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FOR ELEMENTARY GRADES

NATURE STUDY BY MONTHS

BOYDEN.

PART I.

NEW ENGLAND PUB. CO.
BOSTON AND CHICAGO

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NATURE STUDY

BY MONTHS

PART I.

FOR ELEMENTARY GRADES

BY

ARTHUR C. BOYDEN, A.M.

BRIDGEWATER, MASS., NORMAL SCHOOL

BOSTON AND CHICAGO

NEW ENGLAND PUBLISHING CO.

1898

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Be it mine to detect Thy hiding-place and unmask Thee. Be it mine to discover Thy beauty sleeping in the grass, Thy glory hidden in the dust.

MATHESON.

TABLE OF CONTENTS.

CHAPTER		PAGE
	INTRODUCTION	v–viii
I.	*SEPTEMBER.* — THE AUTUMN FLOWERS — INSECTS AND FLOWERS — HOW INSECTS LIVE	1–12
II.	*OCTOBER.* — AUTUMN CHANGES — THE LIFE OF THE LEAVES — DIFFERENCES IN LEAVES	13–22
III.	*NOVEMBER.* — THE HARVEST MONTH — HOW SEEDS ARE PROTECTED AND SCATTERED — GROUPING OF FRUITS	23–31
IV.	*DECEMBER.* — PREPARATION FOR WINTER — EVERGREENS IN WINTER	32–41
V.	*JANUARY AND FEBRUARY.* — ANIMALS IN WINTER — LESSONS ON THE AIR — FORMS OF WATER — COMMON MINERALS	42–60
VI.	*MARCH.* — THE SPRING AWAKENING — BUDS — THE GROWTH OF TWIGS — HOW SOIL IS FORMED . .	61–74
VII.	*APRIL.* — HOW SEEDS GROW — HOW YOUNG PLANTS GROW — DIFFERENCES IN SEEDS — THE CONDITIONS OF PLANT GROWTH	75–86
VIII.	*MAY AND JUNE.* — SPRING LIFE — ANIMAL LIFE — FLOWERS IN THE SCHOOLROOM — PLANT LIFE — BIRD LIFE — THE FISH — THE TREES IN BLOOM,	87–104
	REFERENCES	105–106

INTRODUCTION.

Suggestions For Nature Study.

Love of Nature. The study should include the child's environment, — the living animals and plants, the earth substances, and the forces at work upon them. The child's observation should be the starting-point. The teacher serves as the guide, suggesting material, stimulating and directing the observation and thought. This work should, above all else, lead into a strong love of Nature, an appreciation of the beauty, harmony, adaptation, and plan in the world about us; a sympathy for all living things, which manifests itself in thoughtful care and kind treatment.

Training. The aim is to cultivate in the child what may be termed the elementary equivalent of the genuine scientific spirit, so that out of his native fondness for things about him shall come an enthusiastic, truth-seeking, reverent attitude toward Nature, with boldness to question her, patience to study her, and readiness to be taught by her. Plan in all possible ways for out-of-door observations, as this is the true field of Nature Study.

Expression. Cultivate the various forms of expression, such as drawing, coloring, oral and written language, and in cases that readily admit of it, construction. The work should be closely related to language, spelling, reading, and particularly to literature. It should appeal to the imagina-

tion, and the artist and poet should be called upon to help the child interpret the beautiful. Some of the best selections should be committed to memory. Many applications of number, form, and color will suggest themselves.

As the child understands his own environment he is prepared to appreciate geography as the study of the home of man. The thoughts of the life throbbing through the plant and animal, and of the forces at work about us, all in perfect harmony, and for definite purposes, are suggestions of infinite law. Such thoughts are among the loftiest that can possess the human soul.

How to Plan the Nature Lessons.

Select typical phenomena from the daily environment. A short excursion near the school grounds, or even to the window, is the best form of introduction. Then arrange an exercise along the line of some great nature truth of the season.

Careful work can be begun in a simple way in the kindergarten and primary grades, having each pupil at work observing and thinking for himself. Keep within the range of the child's interest and comprehension. Do not go much into details, but remember that he sees things in a large, crude way; intensive study belongs to maturer years. In the grammar grades the work takes on more of the laboratory plan.

Introductory questions find what the child already knows, or can discover without specific directions. These should arouse the interest, and stimulate to further inquiry, especially out-of-doors. A literary selection or myth often arouses interest at the beginning of an exercise.

Observation of specimens by the pupils should be spontaneous and natural, with as few directions as are consistent with

good training. Individual power to observe always has the element of originality prominent.

The teacher directs pupils in correcting their observations or expressions, drills on the new words and on improved forms of expression, and leads them in thinking of the adaptations and uses. Supplementary reading should be kept distinct from the observation lesson. Literary selections usually furnish the most helpful written language practice.

Drawing, coloring, or modelling (where possible) of the objects observed, in whole or in parts, by directions. These may be on drawing-paper, and particular emphasis should be given to the pictorial and artistic. Color work should be made prominent.

Written description ("story" in lower grades) of the subject should be from an outline according to the language work of the grade. Drawings, descriptions, and literary selections may be bound as a booklet. General voluntary work should be encouraged, e.g., collecting, mounting, labelling, out-of-door observation, silent reading by pupils.

OUTLINE OF NATURE LESSONS.

September. . .	THE AUTUMN FLOWERS. INSECTS AND FLOWERS. HOW INSECTS LIVE.
October.	AUTUMN CHANGES. THE LIFE OF THE LEAVES.
November. . . .	THE HARVEST MONTH. PREPARATION FOR WINTER.
December. . . .	THE EVERGREENS IN WINTER.
January and February. . .	ANIMALS IN WINTER. LESSONS ON THE AIR AND WATER FORMS. COMMON MINERALS AND ROCKS.

March . . . . . THE SPRING AWAKENING.
HOW THE BUDS GROW.

April . . . . . HOW THE SOIL IS PREPARED.
HOW THE SEEDS SPROUT.

May and June. SPRING LIFE.
THE PIPING FROGS.
THE RETURNING BIRDS.
INSECT LARVÆ.
TREES IN BLOOM.
COMMON WILD FLOWERS.

NATURE STUDY BY MONTHS.

CHAPTER I.

SEPTEMBER.

AN appropriate opening of the year's work is through some story or poem that suggests the coming of autumn.

"Where has the summer gone?
She was here a minute ago," etc.

. . . . . .

"The world puts on its robes of glory now;
The very flowers are tinged with deeper dyes," etc.

LOVEJOY'S *Nature in Verse*, p. 188.

THE AUTUMN FLOWERS.

The rich autumn flora preparing its abundant seeds is the most manifest fact of the season.

Flowers can be collected by the children from day to day, and the teacher can aid in their arrangement in such artistic ways as to beautify the schoolroom. These contributions will include both wild and cultivated flowers, which are renewed with fresh varieties as the season progresses. Children assist in the care of the bouquets, that the floral visitors may be thought of as regular members of the school sessions. Children may be encouraged to contribute potted plants of various kinds, to remain during the term.

Fig. 1.

Beautiful surroundings directly lead to that sympathy for natural objects which is the foundation for all true nature study. A little care in selecting plants having a variety of leaf and flower, as well as different habits of growth, will aid in extending this influence, by showing nature's manifold ways in doing her work.

In the morning talks let the children tell where they found the flowers growing, as a means of calling attention to their natural surroundings, and as a stimulus to the search for flowers in their homes. The attention should be called to the value of flowers in beautifying the country road or city park, so that the eyes will hereafter notice such things with a new interest, and a new feeling will stir the heart.

Lists of the flowers collected or recognized may be placed on the blackboard. They serve to introduce the flowers by name to us, and help in fixing the names for future use. Affixing in some

way the color of the flowers aids in recalling the appearance as the eye runs over the names. If the list is continued into the late fall, the hardier flowers will be noticed, and an occasional reflowering of some spring plant may be found. All of these things keep the eyes on the watch, and the thoughts busy on plant life.

Among the more common will be the yellow mullein of the dry fields, the yellow and orange "butter-and-eggs" found along the roadsides, the brilliant gentians, and cardinal flower. The composite family will probably contribute the most specimens, — the small fall dandelion growing along the roadside, the purple asters, a variety of goldenrods, the white yarrow, chrysanthemums, and sunflowers. It is the best plan to use a new set of flowers in each advancing grade. Dana's *How to Know the Wild Flowers* will be found very valuable by the teacher in quickly determining the names and habits of the flowers as brought in by the children.

Fig. 2.

WORK OF THE FLOWERS.

A simple way to bring out this truth with the youngest children is to have them trace by observation the life of a flower, — the growth of a separate flower-stem with green

buds upon it, the gradual opening of the green leaves, the unfolding of the colored flower-leaves enclosing the stamens and pistils. The yellow powder (pollen) on the stamens shows that the flower is ripe, and the bees are busy getting the honey.

Fig. 3.

Gradually the flower-leaves fade and fall off, the stamens soon follow their example, and the green fruit begins to appear. The fruit increases in size till it is ripe, often changing color; then it splits open, and the little seeds escape to the ground, to be ready to make new plants next spring. Thus, in simple form, the life-history of the plant is thought out by the child, and what he sees in one case he is led to find all about him in other plants. The collection of dry fruits containing seeds should be begun now to emphasize the thought.

On the back of the fern-leaves which the children gather are found the rows of little brown pockets, from which can be skaken the powder that will fall to the ground and prepare new fern-plants. Even these plants, without any flowers, are doing the same work of preparation for new plants. Are there any other plants that do not have flowers?

Colors of the Flowers.

To cultivate still further the appreciation of the beauty of the flowers, let the children select the colored papers that will match the colors of the leaves and flowers. These papers may be mounted (under the teacher's direction) on cardboard, to hang beside the flowers for the day. This impresses the thought of the variety of colors, and of the harmony of coloring in each plant. Children in the upper primary grades can aid in pressing some of the flowers, to be mounted on the cardboard with the colored papers beside them. These may hang in the room for a time, by the list of flowers, as another means of interesting the children in the local flora.

Some literary selection will aid in impressing this truth of beauty of the flowers in autumn.

The Work of the Different Parts.

In the *second and third years* the parts of the flower can be examined more carefully for the purpose of expanding the truth already gained. Garden nasturtiums are easily obtained in such numbers that each child may have one to examine. As the first exercise, he should be encouraged to tell just what he sees as he sees it. He will not report the facts in the expected order, but slight guidance will direct him toward the important points, and names may be given as needed (also written on the board in connection with a sketch). In the nasturtium the following may be observed: A yellow cup holds the other parts of the flower. It is cut into five-pointed parts (sepals), and has a long yellow spur on the under side. There are five large orange (?) flower leaves (petals) set in the cup. Three of them have long stems, and the same three have fringes on the inside; the other two

have long dark lines pointing down into the spur. By careful search eight stamens can be counted in the cup, each with a thick part on the end. Some are long and some are short. Probably on one only will be found the powder (pollen), which can be rubbed off with the finger; in the others it is not ripe. In the middle is found another stem-like part (pistil), with no thick part on the end.

Fig. 4.

After the children have told all they can see and think, use a few moments to think of the use of the parts, — the cup, to hold the other parts; the spur, to hold the honey for the bees and butterflies (if not seen, suggest the watching of insects on a bed of nasturtiums). The bright colors attract them, and the dark lines point to the honey.

At another lesson review the observations by teaching the children to use the new names in oral sentences. A few of the best may be written on the board for reading or copying. Still another language exercise may be conducted by giving the pupils a new flower, which they are to describe, using the new names of the parts. Meantime the children will be looking for these same parts in many flowers which they collect, and a little guidance will lead them to use the names as they talk about the flowers.

By bringing in the flowers at different stages, the steps in forming the seeds can be noticed, — the ripening stamens; the withering sepals, petals, and stamens; the lengthening pistil, with the fruit forming at its base; the final formation of the three-parted fruit, with its seeds. Another series of language exercises will naturally follow, and specimens of ripening fruits will be collected.

In the *third year* the toad flax, or "butter-and-eggs," is another flower which can be examined on the same plan, and it can be sketched and colored. More extended descriptions can be written from lists of words, or from a series of questions. The latter serve somewhat as a guide in the formation of the sentences. These papers will show the teacher what further observation or drill is required. Dictation exercises are excellent means of drilling on specific language points.

In the *fourth year* a more careful study of the flower and its development into fruit is desirable. If the nasturtium is used, the following facts will be found; but the same plan may be used for any available flower. The calyx is distinguished, and the children are asked to tell as many facts as they can observe (the calyx is a cup, five parts with sharp points, sepals; three upper sepals extend into a spur; all are yellowish). The corolla is distinguished, and studied in the same manner (five colored petals, attached to the cup, alternating with the sepals, two in one set, three in the other, the latter fringed and with stems). The stamens are found and counted, their length noted, the anthers described, and particular attention is paid to the one that has ripened pollen on it. The pistil is separated from the stamens, and its position noted in the middle of the flower. The use of the calyx in holding the other parts and in protecting them in the bud is thought out; the bright-colored flower leaves, with their odor and honey, are seen to attract the insects; the stamens produce

the pollen, which is carried by the bees to the pistils of other flowers; and the pistil will be seen to produce the fruit. The teacher will need to tell simply the work of the bees in carrying pollen from one flower to another, and its work in forming the fruit. — (Bergen's *Botany*, Chapter XVIII.)

A simple outline written on the board will serve as a basis for the language paper on a new flower, a paragraph being written on each: —

Calyx — sepals. *Stamens — anthers — pollen.*
Corolla — petals. *Pistil —*

A short oral exercise preceding the paper will give an example of the plan of description.

The changes in the flowers will be traced, and particular attention given to the pistil; it increases in length; three branches are distinctly seen, on the tip of which the pollen falls as brought by the bees, while the ovary expands into a three-parted fruit; finally the upper part of the pistil dies, and only the fruit is left with its seeds. For this a subject may be selected as the basis of the language paper — "How a Flower Changes into a Fruit," or "The Story of a Flower." This study is of special value when it stimulates to the finding of other flowers that are changing in the same manner, and thus a truth of nature is discovered. A collection of these fruits is a natural consequence of the interest that has been stirred, and should be begun early in the season.

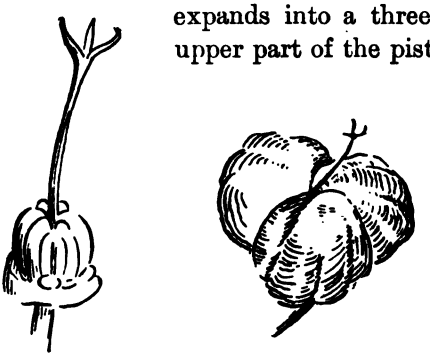

Fig. 5.

Insects and Flowers.

The children should be encouraged to watch the insects that visit the flowers; and quite a list may be made — bees, butterflies, flies, beetles, ants, etc. A more careful watching may tell how they get the honey from the flowers, — a butter-

Fig. 6.

fly kept under glass on some flowers may show his long, spiral tongue, by which he reaches down into the deep tube flowers; or flowers near the open window will invite insects, and their movements may be watched. Their success or failure in reaching the sweets may be apparent, and the reason is at once sought. The teacher may supplement the observation by telling the story of some insects and the flowers.

"Buzz ! buzz ! buzz !
This is the song of the bee.
His legs are of yellow,
A jolly good fellow,
And yet a great worker is he."

For the rest of this attractive poem see Lovejoy's *Nature in Verse*, p. 140. Other appropriate poems may be found in *The Fairyland of Flowers*. The myth of Clytie (the sunflower) teaches a beautiful truth of nature.

The composites are a family of plants in which many small ray and tube flowers are arranged together as if in one large flower. "The flowers thus joining forces make a much braver show than they would if they were scattered, and are thus more likely to attract insects. The chance of gathering honey from so many flowers at once, instead of having to roam here and there in search of it, is greatly appreciated by insects; and their visits are more likely to be effectual, since the chances are that one alighting will touch many florets. No wonder, therefore, that 'composite flowers,' as these are called, are a very wide-spread and successful family." — HARDINGE, Chapter X.

While this is an intricate family to study botanically, yet its simplest lesson is a truth appreciated by the children. This is autumn's richest family in color and in number of seeds, a natural closing of the flower year. "Goldenrod" (Lovejoy, p. 194).

How Insects Live.

"Little inmate, full of mirth,
Chirping on my kitchen hearth," etc.
COWPER'S *Cricket.*

The month of September is rich in certain kinds of insect life, and the preparation for winter is already beginning.

Crickets are among the best insects to keep in the schoolroom for the observation of life habits. Place some earth and sod in the bottom of a large fruit-jar, moisten occasionally, and cover the top with mosquito netting. Large and small crickets will live contentedly during the fall by feeding them on bits of fresh apple or clover-leaves, from time to time.

The following is a simple outline for the teacher to keep in mind during the observation of the habits of insects by the children, —

Where do they live? How do they protect themselves from the birds and other enemies? Will their color help hide them, or make them more easily seen?

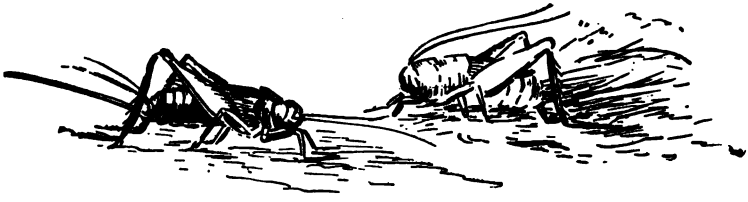

Fig. 7.

How do they move about? Which do they use the more, legs or wings? How fast or how far can they move?

How do they get their food and eat it? Do they injure our crops? When are they most active in getting food?

How do they breathe? How do they make their calls to one another?

Where do they lay their eggs? How do they do it? How do the young grow?

The crickets will answer all these questions for the children if they are patiently watched. They are found under stones and boards, often in little depressions in the ground;

in the jar they crawl into dark places. Being of a dark color they easily escape notice, but at a moment's warning are ready to run or leap away. Their wings are not very large, because they do not use them as much as many insects. They will eat the food given them, and show the mouth parts as they use them, — lips, jaws, and helping parts; they will use their feelers on each other as if talking; the male will chirp by rubbing one outer wing on the other, and the female will lay eggs in the ground by the long egg-tube; the hind rings of the body will beat as the insects breathe; in fact, all the questions that curiosity can ask may be answered. By keeping the jar of soil till spring the eggs will hatch out, and the young wingless crickets can be watched as they grow. Apple and clover can be used for food as before.

There are some fall caterpillars that can be kept in "caterpillar cages," with earth and leaves for food; the eating habits and the changes into cocoons are very interesting. In the spring, from these, and other cocoons that have been collected, the butterflies or moths will emerge, and add another stage to the life-history. Comstock's *Insect Lives* gives full directions for the care of insects. Weed's *Life Histories of Insects* is very helpful in supplying information to teachers.

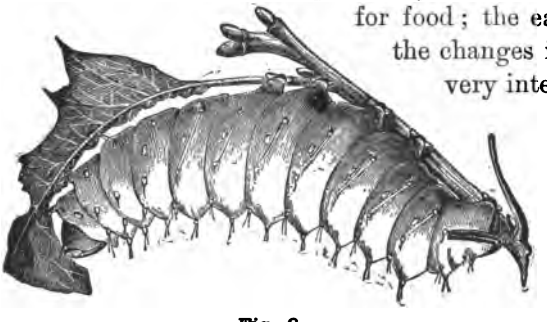

Fig. 8.

CHAPTER II.

OCTOBER.

Natural Phenomena.

The morning talk is the most appropriate time for the weather reports, and for the arranging of the pictorial weather chart. Different designs are in common use by teachers, and are thoroughly enjoyed by the children. The facts observed each day are of little value in themselves, but are used to lead to thoughts of the gradual change that is taking place, — the shorter days, sun lower at noon, cooler winds, early frosts. Consequently the changes in plant and animal life.

The Life of the Leaves.

The beautiful foliage of October suggests attractive material for the children. Some interesting poem adapted to the grade will serve as a pleasant introduction: —

"'Come little leaves,' said the wind one day,
'Come over the meadows with me and play,'" etc.

"'I'll tell you how the leaves come down,'
The great tree to his children said," etc.

"October gave a party;
The leaves by hundreds came," etc.

For the remainder of each poem see Lovejoy's *Nature in Verse.*

Whittier's *Indian Summer* and Longfellow's *Autumn* are among the many selections that are appropriate to older grades.

Autumn Leaves.

The thoughts of beauty can best be impressed through the collections of colored leaves made by the children. The leaves can be pressed and mounted to illustrate different points. These mounts, with the names attached, may be arranged about the room over the blackboards, for the purpose of helping the children recognize the different trees by means of their leaves. A simple study of the colors may accompany this work by the selection of colored papers to match the leaves; these may be mounted beside the leaves. The number and gradation of the different colors will be seen; also some points of harmony of colors can be taught in the older grades. All of this color work is to be used to impress the thought of the rich beauty of the autumn foliage.

Fig. 9.

Mounts of individual colors may be made to impress the prominent colors; e.g., yellow leaves of different trees, red leaves ("crimson," "scarlet"), orange leaves, purple leaves, etc. Guard against poison ivy (Fig. 9), with its three brilliant leaflets, and the poison sumach, "dogwood," with its nine leaflets. These plants are so brilliant in foliage that

they attract collectors, hence it is wise to limit the collections to the common trees. Another set of mounts can be made to illustrate the gradation of colors in the same kind of leaves; e.g., the ash changes from violet through brown, red, orange, to yellow. "The first coloration is usually seen at the veins of the leaf, extending outwardly until the whole is tinted. Sometimes it appears in spots, like drops of blood upon the green surface. The gradations of autumn tints are from dark to lighter hues." There is a helpful chapter on "autumn woods" in Flagg's *A Year among the Trees.*

The Life-History of Leaves.

Begin with the leaves as they are growing on a twig, trace the leaf from the main stem to which it is attached, through the stem or petiole into the midrib and veins, even to the margin of the blade. As the children trace the parts, let them describe what they find at each step. They can think of this as the course of the sap as it comes up from the roots to the leaves, and after it has been prepared in the sun-exposed leaves it will return by the same course into the parts of the tree that need it. The expansion of the petiole at its base enables it to cling firmly to the stem; the strength of the attachment is shown by carefully pulling the leaf from its place. The shape and color of the petiole will be noticed, also the branching of the midrib into the veins. These should be thought of as the framework of the leaf, giving it strength as it is held out in the sunlight. By scraping off the skin from a thick leaf like a plantain, the softer green pulp may be found between the veins. Look for the little hairs on the upper or under side of the blade; these hairs often serve to hold drops of moisture.

This observation of the leaf will prepare directly for the

pictorial drawing of one or more leaves. In this drawing particular attention will be given to the shape and margin of the blade, for the purpose of impressing the thought of the graceful curves that give beauty to the leaf. After this exercise the sketch of a leaf may be placed on the board, with the names of the terms written below as a spelling exercise. These words may then form the basis of a language paper in which the words are incorporated in descriptive sentences.

The next step in the life of the leaves is the change in color, which can be traced until all the green color has disappeared. In a general way, this may be thought of as the ripening of the leaves as they finish their year's work upon the tree. [The valuable materials of the leaves have been absorbed by the branches and roots, to be used again the following spring. The colors depend merely on the changes that accompany the withdrawal of the material from the tissues of the leaf. Frost perhaps hastens this breaking up, but it is not the cause of it. — Bergen's *Botany*, Chapter XII.]

Fig. 10.

Falling of the Leaves.

The third step to notice is the falling of the leaves to the ground after they are fully ripe. Notice which trees drop their leaves early, e.g., ash and horse-chestnut; those that follow in order, — a list on the board encourages the observation; those that retain their brown leaves into the winter, e.g., certain oaks. The leaves fall gently, one at a time, from the trees. The reason for this can be seen in the smooth face across the end of the petiole of the ripe leaf. This is nature's preparation for the winter, as

the load of heavy leaves would be too severe a strain on the branches during the winter storms; also, the trees need a period of rest. [As the material is withdrawn from the leaf, a layer of flat cork cells is built across the petiole; this prevents any wound to the tree as the leaf falls.] The attention should be called to the value of the dead leaves on the ground, covering up the seeds, and gradually decaying to enrich the earth. These thoughts impress the idea of adaptation in nature to each season of the year.

Fig. 11a. Veining of Leaves.
[*Maple for opposite buds.*]

The final step at present is seen in the buds, which are formed on the end and sides of the stem. These are the product of the summer's work, and contain the leaves or flowers of the spring growth. The covering of scales, together with any pitchy substance, protects the buds from winter cold and moisture. The position of the buds tells where the new leaves and branches will appear. In the spring this work is naturally continued by the study of the swelling and opening buds. This will complete the cycle of leaf history.

A drawing of the bare twig will lead to the careful observation of the position, form, and relative size of the buds. Little booklets may be made in the upper primary grades, which will include the mounts of colored leaves, the drawings, the copied memory gems, and the descriptive language exercises. An appropriate cover may have for its title, "The Story of the Leaves."

Fig. 11b. Veining of Leaves.
[*Elm for alternate buds.*]

Differences in Leaves.

(FOURTH YEAR.)

The arrangement of leaves on the branch, and the plan of veining (Fig. 11), as determining the shape of the leaf, should be used to teach a principle of adaptation in plant life. Each leaf is placed so as to get air and sunlight for its growth.

One tree is studied at a time. The elm illustrates a close alternate arrangement of leaves. The leaves are placed on the branch in a spiral line, with large and small leaves so mingled as to give each its full exposure. Often the individual leaves seem to have turned in such a way as to adapt

themselves more perfectly to this plan. Each leaf has a mid-rib, and veins arranged like the parts of a feather; hence the name, "feather-veined leaf" (Fig. 12). Each main vein extends into a tooth on the margin of the leaf, and a careful examination of the curves of these teeth reveals the beauty of outline. The petiole of each leaf is short and thick, the two sides of the blade are far from equal, and no two leaves are just alike. This inequality in the details of the same plan gives another element of beauty to the tree.

Fig. 12. Oak, Beech, Birch, and Chestnut.
[*Back side of leaf for rib.*]

After this preliminary observation the children are ready for the drawing of the twig to show the points more carefully. This drawing is best done by a series of directions which call for careful observation at each step. The artistic selection and placing of the specimen is of prime importance; in doing this each child is encouraged to act for himself. A mounted twig of the colored leaves may accompany the drawing-sheet, or it may be mounted on the same sheet. A sketch on the board with the terms written underneath is a good

Fig. 13.

preparation for the final description, as it gives opportunity for a spelling-drill previous to the writing. These exercises should give all possible scope to originality of expression. Often children like to make a sketch as an introduction to the paper.

The simple thought of the adaptation of this arrangement of leaves is impressed by collecting other illustrations of alternate feather-veined leaves; e.g., apple, birch, oak, beech, and chestnut. Some of these may be mounted to make a class album of autumn leaves.

The maples illustrate an opposite arrangement of the leaves on the branch, with a different spiral from that of the elm. The large and small leaves also are differently placed, but are

arranged to accomplish the same purpose. The five main veins extend from the petiole into the same number of pointed lobes, each of which has its feather-vein plan and teeth with their beautiful curves. The principal veins resemble the palm of the hand and fingers in arrangement, hence the name "palmate-veined leaf." The petioles are longer than those of the elm, and vary in length according to the size of the leaf. The two parts of a leaf are more nearly equal than in the elm leaf, but by folding we see that the parts do not exactly coincide. This arrangement of leaves should be seen to be as appropriate for the maple as was the alternate arrangements for the elm, and the plan of veining is suited to a broad leaf. By trying to place the maple leaves on an elm arrangement, and *vice versa*, the wisdom of each plan will be appreciated. (Bergen, *Botany*, Chapter X.)

In a similar manner to the elm follows the mounting, drawing, and description. The buttonwood (sycamore), currant, grape, and varieties of maple, are further examples. The Virginia creeper and horse-chestnut illustrate the compound arrangement of the same plan; each leaflet is separated from the others on the different veins.

The hickories (shellbark, pignut) and walnuts (butternut) illustrate the compound leaf based on the feather-veined plan (Fig. 14). The position of the bud determines how much is one leaf. The leaflets are opposite, as if made by placing a small blade about each vein, while each leaflet resembles a feather-veined leaf with a very short petiole. This plan furnishes large leaves cut apart to allow circulation of air and sunlight through the foliage. Imagine elm or oak leaves on these branches, and we shall appreciate the fitness of nature's plan. Drawings and descriptions may follow as before, and the leaves suggest designs for the more artistic exercises.

Fig. 14. Shellbark and Walnut.

A simple summary of the arrangement and plan of leaves should close the subject, — simple and compound leaves, parallel- and netted-veined leaves; feather and palmate-veined leaves. In each case the framework determines the shape, and all is arranged to accomplish the purpose best for each kind of tree.

Knobel's *Trees and Shrubs of New England* will aid teachers and children in identifying trees by their leaves. Apgar's *Trees of Northeastern United States* is a little more advanced.

CHAPTER III.

NOVEMBER.

Natural Phenomena.

The weather record is continued, but modified in the lower grades to fit the surroundings. In the upper grades it is used to compare November with October in prevailing wind, temperature, frost, and snow. Note particularly the shortening day and lower noon sun. During these months the harvest moon and hunter's moon suggest simple observations of the moon, and thoughts of its work.

Three supplementary lines add to the value of the work. (1) The telling of myths of the sun, wind, clouds, and stars to the children. These give the childlike approach of the race to nature's laws by means of personification, and thus increase the interest in the "why" of the phenomena. In selecting a myth these points should be in mind: will it appeal to the child; then, does it teach a truth which will be clearer or richer because of the myth. Tell it as a story, enjoy it with the children, and let them have free range in talking about it. Cooke's *Nature Myths* is one of the simplest books; Gueber's *Myths* and Gayley's *Classic Myths* are more advanced. (2) The use of poems and songs of the seasons. These lead to a childlike appreciation of nature's changes, and stimulate beautiful thoughts. There are many selections from Longfellow and Bryant; Lovejoy's *Nature in Verse* is full of selections; Smith's *Songs for Little Children* and Poulsson's *In the Child's World* will give ample choice

of material. (3) Simple illustrative lessons on the direction of wind (magnetic needle and weather-vanes), on the appearance of different clouds, on the movement of the rays of sunshine in the schoolroom and with the color prism. In the third grade definite blackboard exercises on reading the thermometer are given, followed by additions to the weather chart. In the intermediate grades tabular weather records can be placed on the blackboard, indicating wind, temperature, cloud or rain, dew or fog. In the morning talks the relations of these different elements to the weather are thought out; and at the end of the week and month the prevailing wind, the average temperature, and number of clear, cloudy, and rainy days determined and compared.

The Harvest Month.

The sequence of the months suggests the study of nature's fruits for November. This is the harvest month of the year, when the final stores are laid up by man and animals for the winter. Selections appropriate to this thought may be written on the board as memory gems, or copied as the introduction to the November booklet on fruits. Many of them, when read to the children, make the impress which gives an appreciation of the meaning of the autumn in nature's life history.

The following may be suggestive in seeking for suitable material: Whittier's *Autumn Thoughts*, *Autumn Festival*, *The Huskers*, as illustrating an autumn occupation; *The Fruit Gift*, as describing clusters of grapes. Lovejoy's *Nature in Verse*, and the books previously mentioned, have many selections appropriate to the thoughts of nutting and squirrel life, which always awaken a response in the child mind. There are poems, stories, and pictures which are associated

with the Thanksgiving season, and stories of the early Pilgrim celebration after the gathering of their first crops. The current educational papers always have suggestive poems and exercises for use at this season of the year. The spirit of our autumn festival pervading our thoughts of nature is the best preparation for the more extended study of fruits.

How Seeds are Protected and Scattered.

One of the best ways to arouse an interest is through the natural instinct of children to make collections. This furnishes a constantly recurring opportunity to teach the lessons of fruits and seeds. Through all the fall these collections should have been coming in, and are now ready for use. The material can be kept in boxes or bottles, with the name attached.

Fig. 15.

(1) There are fruits which are, while green, covered with a husk or bur for protection — the chestnut with a prickly bur is protected from the squirrels and other animals — until the nuts are ripe, when the bur of itself opens. Inside the bur is the soft lining of hairs which forms a cushion for the young nuts. The ripe nuts are gathered by the squirrels, and stored for the winter; thus many become scattered far from the parent tree, and in the spring will start new plantlets that will grow into trees. The hard shell of the nut protects the seed

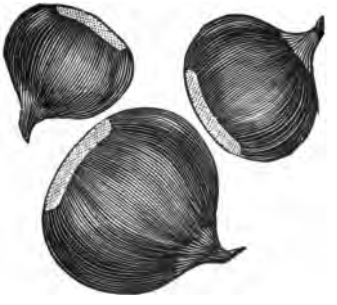

Fig. 16.

from the winter until it breaks in the spring, as the growing seed pushes its way out of its home into the warm light. Even inside of this shell is a thin but tough skin to still further guard the tender seed. By opening the seed there will be found at the pointed end the little plantlet which next spring will push out into the air and down into the ground. The horse-chestnut has a tough outer husk, with only a few prickles upon it. These serve as the protection of the fruit until ripe, when the husk breaks and the nut falls to the ground, but is still protected by a tough skin. Inside the nut, and on one side near the scar, is the young plant. These round nuts easily roll from place to place, and thus are scattered. The walnuts and hickories have also a husk, usually bitter to the taste; these protect the nuts. Besides this is the thick shell with its hard partitions around the soft meat or seed, and even this is still further covered with a skin. These nuts are carried by squirrels to their holes, and many get scattered for new plants in the spring. Other nuts, such as beechnuts and acorns, can be used in a similar manner as the basis of conversational lessons with the little children, to teach the essential thoughts about nut fruits.

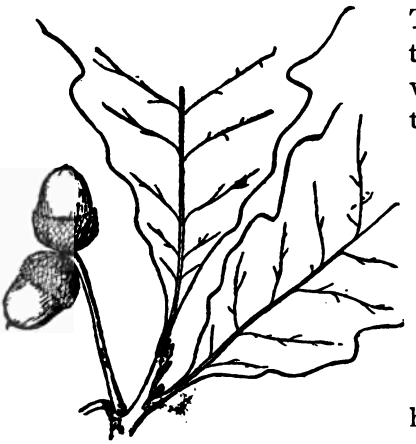

Fig. 17.

(2) Pod fruits may be brought in with the collections; among them will be the locust, catalpa, bean, or perhaps the

milkweed may already have been used. These illustrate another way of protecting seeds until they are ripe; then follows the bursting of the pods in different ways that the seeds may escape.

(3) Winged fruits illustrate another means of scattering. The keys of some maples may still be found, also those of the tulip-tree; while the bracts of the linden and hop serve the same purpose. A tough skin covers the softer parts; and the broad parts act as wings to carry the seeds to new fields, where they will find fresh soil for their spring growth. Many of these fruits are suitable for drawing-lessons.

(4) There are a great many fruits whose seeds are widely spread by means of feathery hairs of some sort; the milkweed is the primary children's favorite. The little nest of seeds, with their silken hairs, is an attractive subject for teaching thoughts of protection and scattering.

The clematis is often used for trimming, because of the large gray plumes of feathery fruits. It is another good illustration of wind scattering. The tall stalk of cat-tail, when picked to pieces, is another illustration of the purpose. The cotton husk from the South is full of seeds packed in the soft fibres, which can be blown by the wind into new fields. The children can see the advantage in all these cases of giving the seeds a new soil in which to grow. Some of the above specimens can be collected in all localities to teach the thought.

(5) There are many fruits which are scattered by the aid of animals. The burdock, with its bur of hooked prickles, is sure to be in the collection, and proves its power to stick to wool and fur all ready for a long journey to a new country. There are so many burs on each plant that the weed spreads very rapidly. The beggar-ticks is another weed whose barb-pointed seed-vessels are sticking to our clothes or to the wool of animals asking to be transported free of charge.

(6) Many small seeds can be collected, such as grass and clover seed, grains of various kinds, which are protected in little scale-like sheaths till ripe, when the grain is blown or falls to the ground. But around it is still a close-fitting skin that is so smooth that the seed is easily rolled along in the rain.

Fig. 18.

(7) Seeds of various vegetables and soft fruits suggest the fruit itself, which, in various ways, held and protected the seeds; and the seeds themselves have means of protection through the cold winter. The pointed ends of many of them indicate the ease with which the seed can be buried in the soil, for in that end the young plant is waiting. The fruit by its color and taste attracts animals, birds particularly; the indigestible seeds are dropped, and thus the plants are widely distributed.

All these seeds, after serving their purpose in the short suggestive lessons, can be saved for spring planting, thus adding to the interest of the germination lessons, as well as completing the life cycle of the plant.

Grouping of Fruits.

(FOURTH YEAR.)

The pupils can be directed to do this along two lines; in the first place, according to the thought of the scattering of the seeds of the plant. The fruits and seeds can be arranged

in this way, and lists made on the board not only of those collected, but of others that are known. (1) Scattered by the wind: milkweed, maple-keys, cones with seeds, clematis, hop, cat-tails, grass-seed, etc. (2) Those that cling to animals. (3) Those that are food for animals. (4) Those that float in water, etc. As different ones are placed in the list, a few minutes' questioning will bring out the thoughts of value, otherwise the list will not be an intelligent expression of the children's knowledge. Each list may serve as a subject for a written paper, using the different specimens as illustrations for the thought. Dictation exercises will be of service in this form of expression. If desired, some sketch may precede the paper in the booklet.

Fig. 19.

Another list may be made according to the kind of fruit. (1) Fleshy fruits, including apple, pear, quince, squash, cucumber, berries of different sorts. These have a soft, protective covering, which is attractive as food, and hence aids in scattering the seeds, often to far-distant countries. The beautifully colored and sweet-tasting fruits tempt man and birds to eat them, thus the seeds are scattered far and wide. Peaches have thus travelled "on their good looks" and sweetness all the way from Persia, where the family originated. The plum and cherry have paid their way across Europe and the United States in the same manner. Oranges, limes, and lemons are carried all over the country for their refreshing juices; and when the fruit is used, the nauseous seeds are sure to be thrown away.

(2) Stone fruits, such as the peach, cherry, apricot, plum, and almond, in which the inner layer of the fruit is hardened into a protecting stone.

(3) Dry fruits, including many "flower-seeds," grains, and nuts. Some of these simply fly about in the air, while others are edible. These lists furnish subjects for written language exercises in which the nature thought is of more importance than mere description. Typical ones in each list will be worth separate lessons, especially in drawing whole fruits, and their sections showing the arrangement of seeds within the fruit. If the time is limited, one of these divisions may be used as the basis of oral language work, while the other is used in a similar manner for the drawing and written exercises.

Fig. 20.

In all this line of work the nature thoughts are to be emphasized, in order that the children may come to appreciate the beautiful truths opened to their vision.

"The plant not only gives birth to the seed, nourishes, protects it, and matures it; like a wise and loving parent it takes care to place its children advantageously in life, and screen them as far as possible from coming dangers."

"Nature, in many cases, takes great care that the seed shall find its way to 'fresh fields and pastures new,' instead of dropping close by the roots of the parent plant into an exhausted soil."

Bergen's *Botany*, Chapter XX.; Hardinge's *With the Wild Flowers*, Chapter XIX., "Seeds on Their Travels."

CHAPTER IV.

DECEMBER.

THE natural phenomena observations should be continued as the basis of the other thoughts. The weather record gives the cold winds, the low temperature, the frozen ground, the cloudy days, and the snow-storms. The wonderful symmetry in variety of the snow crystals attracts the children. The frozen earth holds the snow as a protective covering over the seeds and roots, but as the ground thaws from time to time it slowly lets in the moisture. The leaves are decaying to enrich the soil, the sap stops flowing, or nearly so, and nature seems at rest. The sun rises far in the southeast, is very low at noon, and soon the shortest days of the year will be with us.

PREPARATION FOR WINTER.

The most obvious work of nature has been the preparation for winter. A wide range of observation should be used to impress the truth: the trees and shrubs have lost their leaves, and stored the provisions for spring in the buds and branches; many softer plants die down to the ground, storing the food in roots (beet, carrot, turnip), others in bulbs (onion, tulip, hyacinth), and still others in tubers (potato). The question may be asked of each plant that comes up for observation — How did it get ready for winter? By cutting a hyacinth bulb lengthwise, the protective arrangement of all the parts is beautifully shown. The resemblance of the

"eyes" of potatoes to buds is easily made out, and the abundant supply of food is evident. But a very large number of the smaller plants die, trusting to their abundant seeds to take care of the family in the spring. A variety of sketches illustrating "How Plants get ready for the Winter" will be entertaining and instructive work for some of the pupils, and a review written paper may easily follow the talks.

Fig. 21.

The same thought should be applied to the animals. Most of the birds have gone south because of the cold, and also because their food is gone; the frogs, turtles, and toads are going to sleep all winter down in the mud or earth below the frost; the caterpillars are waiting in their cocoons for the warm spring sunshine; most of the other insects have laid their eggs for the next season, while a few of them have crawled into warm places to wait; the squirrels have gathered a store of nuts, and will soon be asleep in the old tree-trunks; the cats, dogs, horses, and cows have grown a fresh coat of hair and fur. Nothing is forgotten; each is ready in its own best way.

The Evergreens in Winter.

An attractive study for this month is the common "evergreen trees," found in our yards, along the streets, or in the neighboring fields. The first feeling to arouse in the children's minds is of the beauty of the green trees at the time when the other trees have shed all their leaves. These trees have shed all their old brown needles, and are now fresh and green.

One way to fix the different trees in mind is to have a "pine week," in which will be brought in different kinds of pine needles, pine cones, pine sapling, pine wood, things made of pine, etc. Another week may be used for the spruce or hemlock, according to the locality, and arbor-vitæ or cedar week may follow. Pictures of these trees will help show their beauty as large, conical trees, with straight

Fig. 22. Pine.

branches. A small tree may be sawed off, and fixed at the base as Christmas-trees are prepared; this will enable the pupils to see some things that could not be seen in the twigs. In some localities a small sapling, with the roots, might be brought in; this would enable them to distinguish the long, stiff tap-root and the long, tapering side roots that aid in holding the tree firmly in place. The great length of the

main roots and the number of their branches also show how the tree reaches out in the ground for water, as well as to strengthen its hold.

FIRST YEAR.

The pupils will learn to recognize the common evergreen trees, — pine, spruce, arbor-vitæ, hemlock, cedar, according to locality. They will enjoy them as arranged in the schoolroom, thinking of the fresh green color during the winter months, also of the value to birds and other animals in protecting them from the cold and storm of winter.

Fig. 23.
Cedar.

Conversational lessons on the needles will aid in developing the power of oral language as the pupils observe the points and report them. The shape of the needles and the sharp points will be noticed. The number of needles in a bundle can be counted, and different numbers found on different trees, the long needles of the pines are bound together in a sheath, while the shorter single needles of the spruces need no sheath. The arbor-vitæ leaves are wrapped close together around the branches, and so become strong.

The needles in one bundle can be drawn on the blackboard or paper, tied together at the base. The question can be suggested, Why do we call the needles leaves? Different answers will be thought out in a simple form,—they grow where leaves do on the stem; they are green; they fall off as leaves do; and some may find the veins in them as in other leaves. Why are these needles the best kind of leaves for the winter? Answers will be given suggesting the narrow shape as the best to bear the wind and storm; the rain and snow will easily drip or fall from the smooth and pointed needles.

The buds are found on the ends of the stems, and not along the sides, as on other trees. One large bud is in the middle, and two or three smaller ones are clustered around this one as in a nest. The little brown scales protect these buds because they are wrapped so tightly around them, and the sticky covering of pitch keeps out the water and snow that may gather in this nest. These buds have in them the new leaves and branches for next spring. They were prepared during last summer. So the tree rests during the cold months.

Cones.

Cones of some of the trees may be found on the ground, and brought to school. The spruce cones are the best to use, as they will open in the warm schoolroom, and drop a great number of seeds. The cones should be thought of as fruits, because they contain the seeds. The winged seeds are easily scattered by the wind into new fields.

All of these points should come as the result of simple conversations with the teacher, in which the child is encouraged to express his thoughts freely. The resemblances between evergreen and the other trees are to be emphasized this year. Reading from portions of *Hiawatha* will interest the pupils in the ways the Indians used these trees.

SECOND YEAR.

The plan of getting acquainted with the trees can be followed as in the preceding year. The pupil with twig in hand can tell the different things he sees. Where are the needles? They are along the sides of the stem, with a certain number in each bundle, or single ones at each place; most of them are out near the ends of stem. What is the difference between the needles and the leaves of other trees? The needles

Weymouth Pine.

are long and narrow, with sharp points; their stems are very short; the veins are hard to find, because they are so small. The needles of different trees can be compared in length by measuring with inch rules.

Where are the buds? How many do you find? How are the buds covered? Why? What will grow from them? When did the tree get them ready? How do these buds differ from those on the other trees? Such questions will suggest the line of observation, but the pupils should be encouraged to tell freely all they see and think.

A pupil can be given a cone, and asked to tell all he can in answer to the different questions; then another tries it, and thus the power of observation is trained. Of what are the cones made? What is the difference between the green cones and the ripe ones? Where are the seeds? How many

seeds? What kind of seeds? How do cones differ from other fruits?

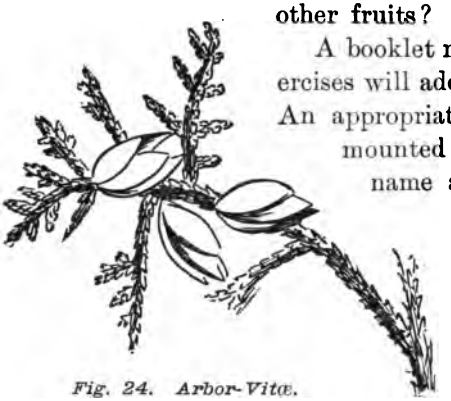

Fig. 24. Arbor-Vitæ.

A booklet made of the different exercises will add interest to the lessons. An appropriate cover is prepared, a mounted bundle of needles with name attached forms the first page, a drawing of the needles, also of the seed with its wing, adds another sheet, and the different exercises furnish others. Often a short literary quotation is copied as a memory gem to add to those already made.

THIRD YEAR.

The Work of the Parts.

The work of recognition is continued as before, except that more varieties are known — white pine, pitch pine, spruce, cedar, arbor-vitæ, and hemlock, with perhaps some smaller evergreen plants, laurel, ground pine. Lists are kept on the board of the varieties brought in, and sketches placed on the blackboard aid in familiarizing with the names.

In the observation exercise a pupil with the twig in hand tells all he can see about the needles; he will naturally tell of their color, form, number, size, or length (measure with inch rule), and arrangement in bundles or singly. Another pupil adds to what the first has seen, until the teacher feels that sufficient points have been noted for the next step. This has prepared for the drawing exercise, in which each pupil draws a portion of the twig, showing the arrangement

of the needles on the stem. Colored pencils or water colors add the new element of beauty, which is appreciated. The adaptation of the tree to winter is the prominent thought.

In a similar manner the buds are observed, and the following points will probably be noticed, — their position on the stem, their arrangement (similar to the plan of branching in whorls), their coverings as a means of protection (the arrangement of the overlapping brown scales, and the position of the pitch). The second drawing should be of a twig, showing the arrangement of one whorl of branches, with needles and buds also. Also an exercise follows on buds as the preparation for the new branches.

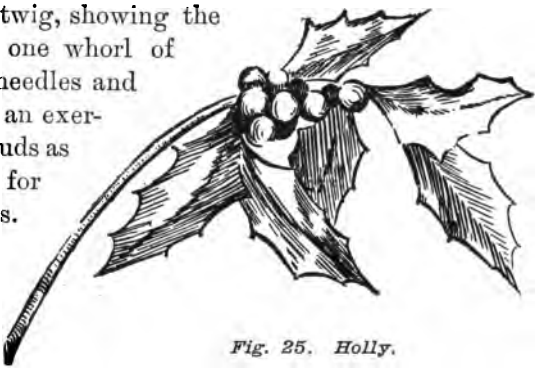

Fig. 25. Holly.

The third observation exercise may be on cones of some one of these trees. The positions of the cones on the trees are noted, either on the growing tree, or on a twig which is brought in. In many trees the cones hang high up, but on the pitch pine or hemlock they are within easy reach. The arrangement of the wooden scales in spiral lines adds to the beauty of the cone, as well as aiding in covering the seeds. The cone is thought of as a fruit adapted to the winter, and the winged seeds illustrate the mode of distribution. A seed can be drawn, as well as a single scale. The booklet arrangement suggested in the second year can be carried out more fully in this year.

FOURTH YEAR.

Life-History.

Lists of the evergreen trees should be made as full as possible, and there may be added to them the names of other evergreen plants that can be obtained — holly, laurel, rhododendron, ground pine. Most of these are used as decorations for the Christmas season. As these are brought in, a few observations should be made on the marked characteristies of each, by which it can again be recognized.

The first exercise may be upon the life of the needles, and the pine is the best illustration with which to begin. The green needles are found on the ends of the branches on the new growth; but no buds are found in the axils of the leaves, as in other trees. Along the older stems will be noticed the scars where the old leaves fell off, and it is to be noted that no new leaves have grown from the old places. By counting the whorls of branches that now have needles on them, the child can find the age of the needles on the tree. The same plan may be applied to trees other than the pine. Drawings can be made to illustrate this point.

Another exercise may be given by comparing the white pine and pitch pine. (1) Needles — length (measure with inch rule), size, shape, number in a bundle, sheath; (2) buds — position, size, number, amount of pitch; (3) cones — length, shape, surface of scales. Drawings of twigs of each can be made side by side for comparison, and from the outline of points a written description may be made. A schedule of comparison often is helpful: —

White pine	five needles in bundle	small buds	long cones.
Pitch pine	three needles in bundle	large buds	round cones.

The life of the cones can be studied if the pitch or yellow pine is available. The small green cones are found on this spring's growth, the large green ones are on last year's branch, while the old ones are left on the growth of the previous years. This shows that it takes two years for the pine cone to mature. In the green cones the scales are very closely packed together, while on the old ones they are spread wide open for the escape of the winged seeds. In the spring the two kinds of flowers are easily found on the pitch pine, and the beginning of the young cone traced.

A review of the trees may be made by grouping the facts about the needles in a schedule form: —

Pines — needles in bundles held by a sheath.

Spruce — short, sharp, three-cornered needles.

Hemlock — short, flat, blunter needles, under side lighter colored; short stem to each needle.

Cedar — scales wrapped about a round stem.

Arbor-vitæ — scales wrapped about a flat stem.

These facts will serve as material for descriptive sentences about the group of evergreen trees. The collection and sorting of cones also will aid in the review, — the large cones of the Norway spruce, the different pine cones, the smaller cones of hemlock and arbor-vitæ, and the blue "berries" of the cedar. These varieties can be kept in separate boxes, with proper labels.

Many appropriate quotations can be found regarding evergreen trees in Longfellow and Lowell, which can be copied and learned. A booklet on the group of trees will be as interesting as in the lower grades.

CHAPTER V.

JANUARY AND FEBRUARY.

Animals in Winter.

Many conversational exercises may be had with the children on the adaptation of the different animals to the cold of winter. Such lessons should lead the children to express their thoughts and feelings freely about the protective care that guides the habits of these animals. These bring the children into sympathy with animal life; with its habits. Some suggestive questions will lead the way to many interesting thoughts. Where have the insects gone? (Many caterpillars are in cocoons; butterflies, moths, and many other insects laid their eggs and died; some bees and wasps are sleeping in warm places, etc.) Where are most of the birds? Which birds are with us for the winter? This latter question will lead them to be on the watch for the birds, such as sparrows, crows, woodpeckers, blue jays, chickadees, etc. The

Fig. 26. Chick-a-dee-dee.

English sparrows by their abundance may do at least one good service in giving opportunities for the study of bird habits. These questions will suggest the line of observation: Where do they live? In what different places have you seen their nests? Of what are they built? How carefully are they made? What do they find to eat? (Note the fitness of the conical bill for picking up and crushing seeds.) Learn to distinguish the male from the female (the male is brighter colored, because of a white bar on the wings, and the black throat and breast). What are the different things you have seen them doing? (Habits of flying in flocks, of noisily quarrelling about their food, of trying to drive off other birds.) These are out-of-door illustrations to teach how birds adapt themselves to winter conditions in keeping warm, getting food, and protecting themselves.

Most of the domestic animals are fitted to withstand the cold by the growth of a new warm covering of hair, fur, or wool. In the summer this covering is shed, so that the heat shall not be felt too much, and the feathers of the birds are moulted, but as cold weather comes on the new covering grows. These facts are intended to impress the thought of adaptation to climate, one of the great truths of animal life. A collection of pictures of different animals in their homes will add to the interest, and often suggest new questions for thought. The object of these lessons is not zoölogy, but rather a childlike appreciation of animal life. Johonnot's Readers are full of stories of common animals.

FIRST YEAR.

Flesh-Eating Animals.

The Cat Family. The common domestic animals are the best as a starting-point, then, by pictures, others can be intro-

duced. Emphasis is placed on the animal habits, introduced by some suggestive question, e.g., How do the animals get their food? The cat has soft, tough cushions on the bottom of her paws; these help her to quietly crawl up toward her prey till she is near enough to spring. She has sharp claws, five on the front feet and four on the hind feet; these can be drawn in and out of sheaths, and so can be quickly used in seizing the food or in climbing for it. The sharp teeth in front are fitted for cutting the flesh, while the long, pointed teeth are used for tearing the food in pieces, as well as holding the smaller animals in her mouth, and the back teeth have pointed tops to aid in crushing the food. All the teeth are made for eating flesh. This may be still further impressed by comparison with the human teeth.

In finding the food the bright eyes are used, especially in the night, when many of the smaller animals are running about, or in dark places where the cat hunts for her food. Observe the pupil of the eye when it is a vertical slit, and when it opens in a large circle. The cool, moist nose can smell very keenly, and the long, sensitive whisker hairs about the mouth help her find the way in dark places. The erect ears are ready to hear the slightest scratching of a mouse. All these things make the cat a good hunter for us. The rough tongue is used not only for cleaning her fur, but in cleaning the bones of all the meat, and in lapping water and milk.

Pictures of flesh-eating animals of the cat family will illustrate the same characteristics, — the lion, tiger, panther, etc. The children should try to find in the pictures as many of the parts of the cat as they can. Why are these animals more dangerous than the cat? They are larger and stronger, and can crush much larger animals; they are fiercer, and cannot easily be tamed. Where do they live? In the warmer countries, in the forests, and some of them spring from the trees on

unsuspecting animals; they are very wild, and often do a great deal of damage by coming at night around the settlements. Men who are off among the forests have to be on their guard all the time.

The Dog Family. The dog will serve as a basis of comparison with the cat family. The same tough cushions are on the paws; but the claws are not as sharp, neither can they be withdrawn into sheaths. The dog rushes for his prey, running long distances, digging into the holes, and finally holding it in his strong teeth. He hunts more in the daytime. The same keen scent and quick hearing make him an excellent hunter for us. But the dog can be trained to go with us and hunt, and hence becomes more useful than the cat. His intelligence makes him a good watch for us during the night; for he not only is keen to scent danger, but he can tell his feelings by the different barks and calls. The teeth are used in a manner similar to those of the cat, except that the back teeth are used some for grinding; but the tongue is smoother, and in warm weather it is held out of the mouth, probably to aid in perspiration.

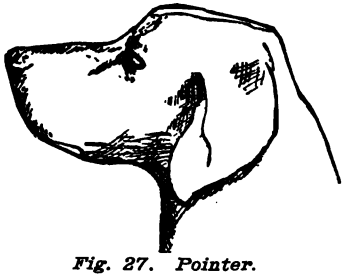

Fig. 27. Pointer.

Other members of the dog family are somewhat familiar through pictures and stories, — the wolf with his savage habits, the fox with his cunning. All of these lessons impress the children in a natural way with the thought of the adaptations of the parts to the life habits. Particularly interesting is the application of these lessons in stories and pictures of the Esquimau dogs. Considerable is possible in interesting the children in the life of these people of the north: their

houses, how built, furnished, and warmed; the dogs as trained to draw the sledges; the boats and weapons used in hunting the bear, seal, and walrus; the dress and sports of the children. Stories of the sagacity of the St. Bernard dogs in saving travellers lost in the snow add still more to their appreciation of the usefulness of the dog to man. Passing to

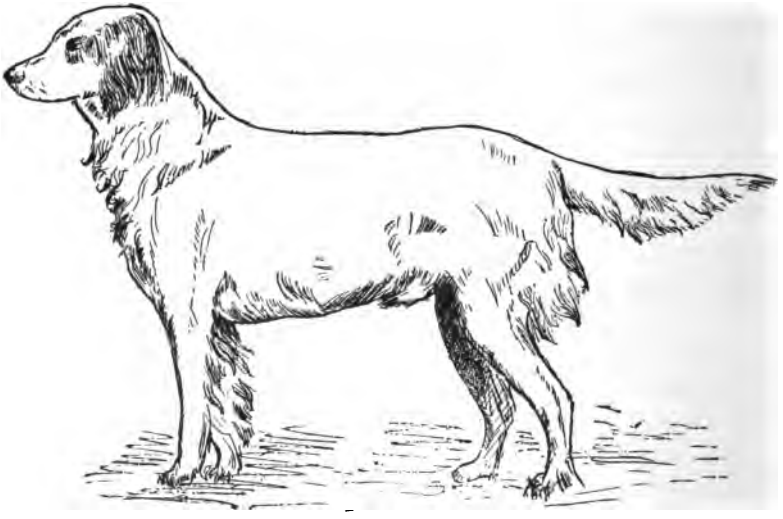

Fig. 28.

warmer climates, there are pictures of the shepherd dogs herding and protecting large flocks of sheep. The nature spirit of this teaching is that intense sympathy for animal life which comes from this closer knowledge of their habits and life. A great many pictures can be contributed by the children. The free oral expression will lay the foundation for later reading-lessons.

SECOND YEAR.

Grass-Eating Animals.

A review can be taken of the flesh-eating animals, with much oral expression of the facts. This serves as an excellent preparation for the comparison with the grass-eating animals. Pictures brought in by the children may be pasted on the papers used for written sentences, and thus increase the interest and value of this form of expression.

Of the grass-eating animals the most familiar will be the horse, cow, or sheep. As others are thought of that have come into the experience of the children, a simple list may be written on the board, and pictures of these that are brought may be hung up beside the list. Among these will be the deer, goat, giraffe, camel, buffalo, antelope, moose, zebra, rhinoceros, elephant. Children are interested in new animals, and pictures are available in all of these cases. The bear is an intermediate form, feeding both on flesh and vegetable food.

How do these animals get their food and eat it? Use the observation of the children; supplement by use of pictures and diagrams on the board. The horse uses his flexible lips to bring food into his mouth, then the sharp, cutting teeth bite it off, while the large, rough back teeth grind it into fine pieces. The long, sharp teeth, such as the cat and dog have, are not needed by the horse for tearing his food. The long tongue is used in putting the grass into place in the mouth. In the cow the upper front teeth are not present; hence the long tongue is used in twisting off the grass, pressing it against the sharp lower teeth. Explain chewing the cud. The same is true of sheep, goats, and deer. The thought to be emphasized is the fitness of the teeth of different ani-

mals for their food; and the thought can be broadened to other animals the children know, — the bill of birds for picking up seeds, the small teeth of fish for holding slippery little fish, the gnawing front teeth of the squirrel used in eating nuts, etc. After the free oral exercises many simple descriptive sentences may be formed by the children and written, or from lists of words the children may make their sentences. Other forms of language exercises appropriate to the grade may be used.

Hoofs. This peculiar formation of the foot adapted to its life makes the animal still more interesting. The number of

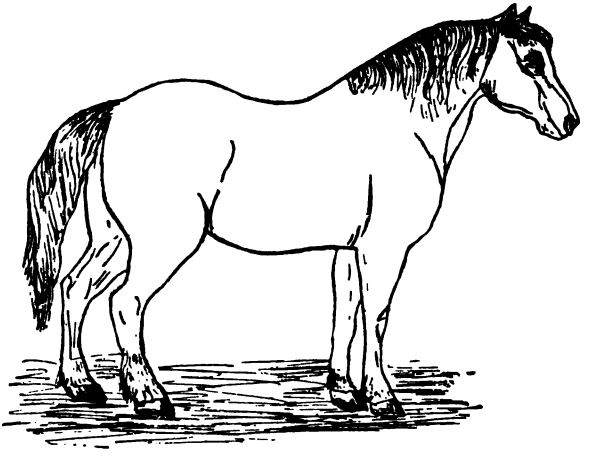

Fig. 29. Arabian Horse.

hoofs on different animals should be noticed; the horse has one large one, while most of the others have a double hoof on each foot. The oxen have large, strong hoofs, that make them useful to us in drawing heavy loads; the deer, sheep, and goats have smaller ones, that help them in running fast; the horse has the single hoof, that is strong, and we can drive

him over the road with heavy loads. All these animals can travel easily over hard and rough places in search of their food. The hoofs are like the nails on our fingers and toes, hence the animals walk on the tips of their toes; the hoofs can be cut as the nails are, and we can drive iron nails into them to hold the shoes on. The animal is fitted not only for his own life, but also fitted for man to use as he needs him. This thought of the fitness of the limbs for use can be expanded to other animals, — the claws of birds, the fins of fish, claws of lobsters and crabs, etc. Encourage the children to freely express their feelings of the fitness of the parts.

What Animals know and can do for us. Let the children describe their pets or home animals, telling how much they seem to know and understand, how they express their wants and other feelings. By suggestive questions certain lines of thought can be started: Why is the horse so useful to us? What are the different things we get from cows? Which is the more useful to us, the sheep or goat? Why should we be kind to animals? The answers will furnish abundant material for some of the regular language exercises for the purpose of increasing the child's vocabulary. Many of the reading-lessons may serve as occasions for teaching new points about animal habits.

Animals of Other Countries. By pictures and stories the interest may be broadened. These stories should be reproduced by the children. The camel is the animal fitted by his softer hoofs for walking long distances over the hot sands of the deserts, carrying men and loads. Some other prominent facts can be seen from the pictures, — the long legs, the hump of fat on the back, the long neck by which the tall animal can reach up or down for its food, the large lips by which it picks up the food. The gentle disposition makes it possible to train the animal for great usefulness to

the people of those countries. The meat is used for food, the milk for drink, and the hair for cloth.

The elephant is attractive because of the long trunk, which has on its end an appendage which serves as a sort of finger for picking up its food. This trunk is very strong, and the elephant uses it for many things; it smells with it, touches things to find out about them, and defends itself with it. The trunk takes the place of the long neck which some of the other animals have. The long tusks are the pointed teeth of the upper jaw, and are useful in defence. The ivory made from these tusks is very valuable. Pictures will show what heavy loads the large body carries. Often men use the elephants in hunting other animals; the thick skin protects them from their attacks. The broad foot is fitted to bear up such a huge body. The animal is so docile that it can be trained to do a great deal of work in carrying loads, drawing timber, etc.

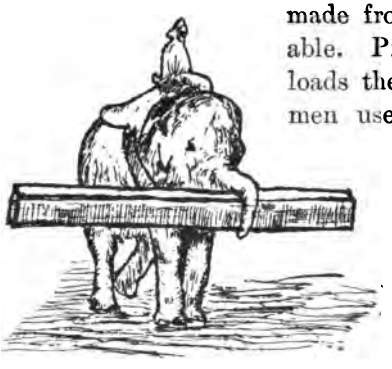

Fig. 30. Elephant Carrying Timber.

The reindeer, with its long and branching antlers, is another very interesting animal of the cold countries. It is used by the people of these places as the horse, cow, and sheep are used by us. It is trained to draw heavy loads over the snow on the sledges, and it can travel very fast and for long distances. The deer feeds on moss and lichens, which it finds beneath the snow by digging with its hoofs. The meat is used for food, the milk for drink, the skin for tents, the hair for cloth, and the bones for tools. A very useful animal.

The facts about these animals should be woven into interesting stories, and told to the children. They should be encouraged to talk freely about the animals, and finally reproduce much of the story. The purpose is to impress the value of the domestic animals to man, and the perfect fitness of the animals to their surroundings.

THIRD YEAR.

Lessons on the Air.

The best introduction is to lead the children to tell what they can about the air; it cannot be seen (transparent); it can be felt (warm or cold); it moves in different directions (it presses in all directions). Then the teacher can complete the ideas by teaching any needed point or term. Apply the term "transparent" to different substances; use it in sentences which suggest the use of this property in the substance; e.g., water, glass, mica, etc. Apply to the weather record in noting the direction of the wind and its force (light, strong, gale, or hurricane); notice the weather resulting from the principal directions of the wind (northerly, easterly, southerly, westerly); continue to note the prevailing wind and weather of each week and month. These observations may easily furnish material for arithmetic examples. An illustrated weather record on the blackboard, by its attractiveness, adds to the interest of the observations; and a simple weather-vane prepared for the schoolroom makes the observation more accurate.

Continue to read the thermometer; give a simple explanation of it as a preparation for a drawing-lesson, in which a simple diagram is made of the tube, bulb, and scale. Apply this knowledge in the weather record for the purpose of no-

ticing the relation of the temperature to the direction of the wind.

Apply to the currents of the air in the schoolroom. (1) Try at the openings of windows and doors with a burning candle or match to find where the air is pressing in and out, showing that there is a circulation of air. Notice where the air is cold, and where warm, to give the idea of the constant movement of air in and out of the room. (2) Use the thermometer to measure the temperature at the top of the room, also near the floor, then half way from the floor to the ceiling. Try in different parts of the room. What does it teach us? With bits of floss find the currents of air in the room, the upward current in some places, the downward current in others, to illustrate the idea that warm air is lighter than cold air, and so is pressed upward by the latter. Show in a simple way how the schoolroom is warmed and ventilated to impress the value of currents of air.

Forms of Water.

Suggest common illustrations of water passing into vapor; call on the children to give their explanation of the change; e.g., damp cloth, wet blackboard, water on window, etc. Think of water changing into particles too small to be seen; use the word vapor in stating the facts. Think of the heat of the sun or of fires as causing the changes. All that is needed is to stimulate the children to think out the facts for themselves; then re-express the facts, using the new terms. Each child might write sentences about vapor.

Call for illustrations of the change of vapor back to drops of water; think out the fact that cool air will cause this change; e.g., water on window, breath on cold morning, "steam" from hot water, etc. Name forms of this action seen out-of-doors at different times, — dew on grass, fog over

low land, clouds in the upper air, drops of rain from the union of fine drops of cloud, crystals of frost on grass, crystals of snow from the clouds. Think of the circumstances under which these return again to vapor, using all the facts to impress the idea of the circulation of waters from earth to air and return, and think of its value to us in various ways. Apply in the weather record as occasion occurs, noting the relation of temperature and direction of the wind to the moisture in the air, especially in case of rapid changes.

Common Minerals.

The object of these lessons is to find some of the more common properties of solids, in preparation for later lessons on building-stones and soils, or to show why man can use rocks and metals.

One of the best specimens for beginning is *mica*. Small pieces may be distributed to the class for observation. A few general questions will be sufficient to start the work; after that, only guidance is required. What do you see? They will tell of the color, the thin leaves, the shining faces (pearly lustre), the sharp edges, the transparent leaves. These facts will be told in simple form; and the teacher should give the new terms, and drill upon the language expressions. What can you do with it? They will bend it, and notice that it flies back (elastic), unless too much bent, when it breaks; they can pick it apart into many small leaves; they can scratch it easily with the finger-nail (soft); they can cut it easily with the scissors. Different geometric forms may be cut and drawn as an application of the form lessons. Where can mica be found? In some places the granite rocks are full of pieces of mica, and collections can be made by the children. Where have you seen it used?

They will have seen it in stove-doors, used because it is thin, can be cut and bent into shape, and it doesn't burn or crack in the heat. Some have seen the fine scales used for ornamental work because of the shining or sparkling lustre of the small pieces.

Written expression can easily be planned by writing a series of the new words on the black-board as a spelling-exercise, to be followed by the making of sentences using these words.

The next mineral should be one that can be compared with the mica, and *glass* is naturally suggested. Let the children work this out by themselves. How is glass like mica? It has smooth, shining faces; it has sharp edges; it is transparent; it is used in windows. How does it differ from mica? It is much harder; it is thicker than the leaves of mica; it cannot be split into thinner leaves; it breaks when it is bent; it cracks when heated; it isn't found in rocks, but is made by man. What things are made of glass that couldn't be made of mica? This tends to emphasize the properties still further. Apply the ideas hard and soft, as found by scratching, to other substances; also the term elastic.

Another mineral useful in teaching the common properties of matter is *marble*. The same plan of letting the children work it out for themselves should be used. What can you see? It is white (perhaps other colors may be obtained), it is made of small shining pieces (crystals). How hard is it? It can be easily scratched with an iron nail, but not by the finger-nail; it is soft, but harder than mica; it is softer than glass. Why is it used so much? It can be cut into different shapes because it is soft, it can be polished beautifully, there are many colors to marbles. Written work can be planned as with mica. The best material for comparison is *chalk*. What is it made of? Fine particles then rub off

easily; they do not shine as did the crystals of marble. Which is the harder? The marble will scratch the chalk because it is much harder. Why cannot chalk be used as marble is used? It is too soft to be cut into good shapes, and it cannot be polished. The chalk breaks easily into pieces (brittle); the small particles are called grains. Apply the new terms to other substances. Follow the observation by written comparisons.

Quartz is another mineral of properties so different from the above as to be valuable for comparison. A piece of common milky quartz is given to the pupil for him to tell all he can about it, the previous practice being a sufficient preparation. The quartz is whitish, not as white as snow; sometimes it is grayish, and some pieces may be reddish. It has rough faces, sharp edges and points. It is very hard because it cannot be scratched with an iron nail; in fact, the iron color of the nail is seen as a mark on the quartz. It can be used to scratch glass by rubbing a sharp point on the glass face; this shows that it is harder than the glass. It can be broken by a blow, and is brittle. Some specimens of quartz of different colors may be shown to illustrate some of the valuable uses; e.g., amethyst, rock crystals, smoky quartz, agate, etc.; and perhaps some of the children may be able to contribute illustrations. Where can quartz be found? In the rocks that are called granites, in large lumps found in stone walls, etc.; in sand it is the main substance. This will lead to collecting granites and sand. It will be found helpful to let the children get small pasteboard boxes in which to keep their minerals as studied; this plan facilitates comparison. Boxes of miscellaneous specimens as brought in can be used for exercises in sorting, which is a valuable way of teaching discrimination.

The common *metals* may be collected and distinguished

by name, a list placed on the board, a search made for different metals found about the schoolroom or building. Iron in all forms is attracted by the magnet. Tinfoil and tin plate are known by their color, but the magnet attracts the latter because the tin is used for coating iron plate. Lead is known by its color, softness, and the ease with which it bends. The metals are flexible, and many uses result from this property of bending and remaining bent. Steel needles, knife-blades, and springs are elastic; they would lose their usefulness if flexible.

Copper is known by its red color, and many uses can be thought out; it is flexible. Zinc is bluish, and has some common uses that are easily noticed. Other metals may be treated in the same manner, the main object being to teach to distinguish by some characteristic property; and the use emphasizes the point. Practice in sorting is particularly helpful.

FOURTH YEAR.

The purpose of this year's work is the enlargement of the thoughts of the previous year.

Natural Phenomena.

The weather record for A.M. and P.M. can be more broadly understood; the terms of temperature understood, 0°–32° very cold, 32°–45° cold, 45°–60° cool, 60°–75° warm. The meaning of 32° as the freezing-point is discovered. Frost and snow can be made clearer by studying and sketching the crystals on some day when the flakes of snow are large. Catch the flakes on the nap of a piece of black cloth; thus quick observation can be made. Patterns of snow crystals (J. L. Hammett Co., Boston) are useful to supplement the above exercise in showing the variety of forms which the same plan may take; the six

rays are always plain, though there may be an almost infinite variety of ornamentation. This shows one reason for the great beauty of the snow. The same may be looked for in frost forms on the window, on the grass, in thin ice. Averages can be made from the temperatures of the week; why is one week warmer or colder than another? The apparent movement of the sun can be observed by watching the course of the sunlight across the schoolroom; the places in the horizon where it rises and sets can be noted, and the change of the time as spring comes on. The movement of the moon and its phases can be traced by simple directions, drawings can be made of its appearance at different times, and the places where it sets and rises noticed. Some of the stars, and groups of stars, may be observed if the teacher is situated so as to aid the children on some bright evening. Their movement through the sky should be noted as a help in understanding certain geographical ideas. This also prepares the way for some of the myths about the stars; these may be told or read, and reproduced. The purpose of this line of observation is to open the eyes and thoughts to the beauties of the heavens. "The heavens declare the glory of God."

Formation of Crystals.

Some simple experiments may be performed by the teacher which call attention to the forces at work on substances. Dissolve rock-salt in the least amount of warm water, and pour out into a saucer. Think of the separation of the salt into very fine particles in the water till they are invisible. Apply this thought by making a list of substances that will dissolve in water, also of those that will not dissolve in water. Let the children describe orally the experiment that was taken, with the result; it can also be used for a written exercise if desired.

As the water cools and evaporates during the day, the changes may be noticed in a general way; after all the water is evaporated, a more careful examination may be made. The shining faces of a very large number of little crystals can be seen; perhaps some of the larger ones will show the plane faces distinctly, and the cubes of salt appear. Think how this came about; as the water evaporated, the little invisible particles of salt began to collect, slowly they united into larger ones, and finally the crystals were large enough to be seen; these kept increasing till the form became plain; and when all the water had evaporated, all the salt had gathered itself into crystals. The remarkable thing is that they all collected into cubes; but this illustrates the same law we found in the snow crystals, which always formed six-sided crystals. Similar experiments may be made with alum or sulphate of copper, which may be obtained of the druggist.

The oral and written description can be added to that already given; dictation exercises are very helpful in improving the form of expression. Some good crystals of quartz or other mineral will emphasize the regular arrangement of the plane faces and angles. Specimens of rocks containing veins of quartz or of other minerals illustrate the same process in the earth. Specimens of ores of metals also show that this process was a very important one.

Crystalline Rocks.

An application of the lessons on crystals can be made by a collection of the common building-stones of the locality. The granites will be found to be made up of crystals, as shown by the shining or plane faces. If coarse granite is available, the different minerals may be distinguished, — the shining brown or black leaves of mica, the whitish or pink faces of

feldspar crystals, and the glassy quartz, often of a smoky color. These same minerals may be looked for in other pieces of granite, a list placed on the board, and a simple description of granite given and written.

Another exercise may be had on the uses of granite as a building-stone; where they have seen it used; why it is so useful (hard, wears well, can be cut and polished, has so many colored crystals in it, is found in large quantities); where it is found and how prepared (pictures of a quarry). Other kinds of granite may be brought in. The Quincy granite has a greenish-black mineral called hornblende in place of the mica. In eastern Massachusetts diorite is common, composed of the feldspar of the whitish or grayish color, and hornblende; both of these are crystalline. In many places the rock has distinct layers of the same minerals as are in granite; then it is called gneiss; this also is much used as a building-stone. As the children learn to distinguish the rocks, they may be interested in labelling them as a little collection. A written exercise may be prepared on the uses of granite or gneiss according to the locality.

Marble is another common building-stone; it is made of small crystals of one kind very closely packed together. This is a soft stone, that can easily be cut and polished. A piece placed in water does not dissolve; but if placed in water to which some (hydrochloric) acid has been added, it will dissolve very easily, with the formation of many bubbles of gas. Pieces of shell or coral will dissolve in the same manner, thus proving that they are made of the same substance as the marble. This illustrates one more way of dissolving solids. Many different-colored marbles may be collected. This serves as a basis for another description, and comparison may be made with the granites.

Sandstones and slates are also common building-stones;

the former is made of grains of sand (broken quartz crystals) stuck together by a fine powder of clay between the grains. The brownstone variety is probably the most commonly found in buildings, and is a durable stone because of the quartz in it. Slate does not show crystals; by scratching it the fine grains of clayey nature are found. The many uses and the reasons for the same are obvious, and will easily be stated by the children.

A list of the common building-stones of the town may be written on the board, perhaps in the order of their abundance. Sketches of granite are valuable to show the arrangement of the different minerals, as indicated by different degrees of shading; such an exercise calls for careful observation. These exercises should be centred about the collections, as they form a part of the local geography lessons.

CHAPTER VI.

MARCH.

THE SPRING AWAKENING.

"Old Mother Earth woke up from her sleep,
And found she was cold and bare;
The winter was over, the spring was near,
And she had not a dress to wear."

STARTING with the thoughts suggested by the above lines, the children can be led to watch for all the indications of the coming spring. All the changes may be associated with the one great thought of nature's awakening from the winter rest. The sun is rising earlier in the morning and setting later each evening; its position each noon is higher, and the middle of the day is, therefore, growing warmer. The warm rains are soaking into the ground as the frost comes out, and the green grass begins to start in favored places. The buds on the trees and shrubs are swelling, the first flowers are peeping out in the warmest places, seeds are beginning to feel the thrill of the new life, frogs come out into the pools of water to begin their calls, and the bluebird is occasionally seen in his new home. The schoolroom may become a miniature representation of the out-of-door activity; twigs, bulbs, seeds, tadpoles, early flowers, and leaves, etc., can be brought by the children. A few things at a time can best be handled, and they will be suggestive of many conversational exercises and of reading. Some of these early discoveries may be noted in the simple calendar of the month, and thus in-

crease the watching for indications of spring. As a botanical preparation the study of the chapters on buds in Bergen's *Elements of Botany*, or Newell's *Outline Lessons in Botany*, Part I., will be particularly helpful.

FIRST YEAR.

Buds.

(1) Begin by leading the children to recognize some of the common trees by means of the twigs which they bring in, — the willow with its pussies, the horse-chestnut with its sticky buds, the cherry with its clusters of rounded buds, the elm with its large flower-buds and small leaf-buds, the red maple with its red stem and clusters of buds. A few words in conversational form as the twigs are brought in will lead the children to express their general observations and feelings, as well as give the teacher the chance to make the right beginning in this series of spring exercises. These twigs should be trimmed, and placed in separate bottles of water, with the names printed and attached. By changing the water, and renewing the cutting of the ends of the stems, the growth takes place more rapidly. This may be explained to the children in a simple manner. Some twigs may be placed in the sunlight, others in the dark, to notice any difference in the growth. These twig exercises should help in the recognition of the trees of the school-yard, or of those seen from the windows.

(2) The means of protection in the different buds. The close wrapping of scales is found in all; and in most cases it will take considerable picking with a pin to separate them, so closely are they bound around the outside. Why should this be so? Why do the buds need this covering? In the

willow a hard brown scale covers each little cluster of flowers, and both scale and cluster are set safely on a small shelf on the stem. If we examine these scales, we find they are very smooth on the inside, and are curved into a cup to hold the soft white "pussies." The downy white hairs that give the name "pussy" to the flower cluster are meant to keep the flowers warm during the winter. Some buds will be found with a sticky substance on the outside, to keep out the water that might get in and freeze; and the buds on the evergreen trees are covered with pitch to keep out the water. This should be conducted as conversational exercises, in which the natural thoughts of the children are expressed and used. The teacher serves as a guide in directing the thoughts into useful lines. By seeing the facts of protection in many specimens, the thought is impressed. The teacher may place artistic sketches of different twigs on the board, with their names. This helps teach the beauty of form, and some of the children of this grade may begin their own sketches of twigs.

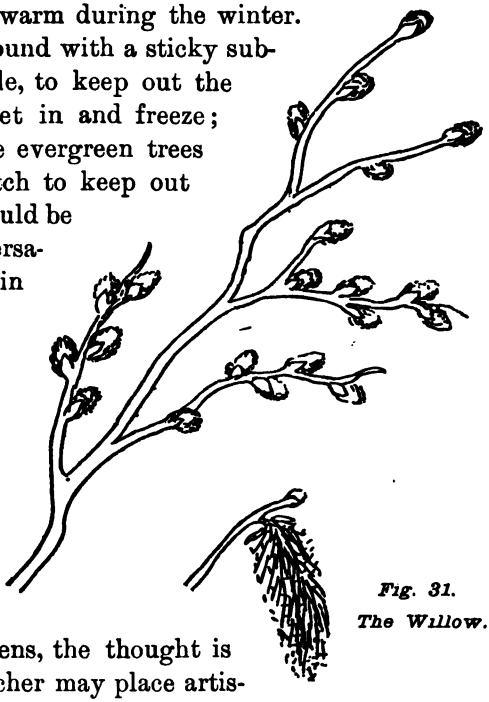

Fig. 31.
The Willow.

(3) The changes in the buds as they grow in the water. Each day look carefully for any signs of change, and carefully report them,— the opening of the scales, the first appearance

of the green leaves, the first tinge of yellow or green willow-flowers in the pussy, the wool wrapped around the folded green leaves to keep them warm, the unfolding leaves or flowers as the different parts become distinctly visible, the growing branches, new leaves appearing, falling of scales, etc. Naturally comparisons will be made as the different twigs grow, — some grow faster than others, the scales open in different ways, the leaves are not folded in the same manner, and the formation of flower clusters is very different. All of these things intensify the interest of the children in watching the wonderful phenomena of growth. Sketches of unfolding twigs make beautiful blackboard decorations.

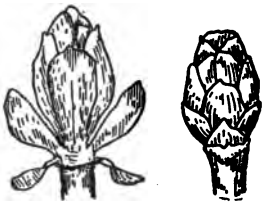

Fig. 32.

Encourage watching for similar changes in the trees out-of-doors; let them report or bring in specimens as fast as the changes appear. The thoughts of the warm sun and flowing sap as a promise of spring, of the whole plant awakening to new life after the winter rest, of the roots at work gathering water from the soil, of the stems carrying it to the different parts of the tree where it is needed, — all impress the nature side of plant growth. Other signs of spring life are carefully watched; and on warm days many such are apparent, even the birds and insects.

Language. In this year it is largely oral, and it is used as the expression of the child's instinctive thoughts of what he sees about him in nature. It is natural for the child to think of the Divine Hand preparing the world anew for its spring and summer growth. The spontaneous child view of nature is to be encouraged, and the foundation is to be laid this year for the nature study of his life. Many of the ideas

and words can be woven into the early reading or copying sentences, and some teachers have hectographed a series of simple sentences derived from the observation exercises. The earliest reading-books and charts may have material that naturally fits the work, but the fundamental object of the work is to bring the children into hearty sympathy with the ways of nature. It is a helpful thing to read to them appropriate poetic selections, so that they may feel the meaning through the beautiful form of expression. Good pictures may be used to cultivate the same feeling; and the child's own sketches have the same purpose in mind, especially if they are colored.

SECOND YEAR.

Growth of Twigs.

Continue the recognition of common trees by means of their twigs, as suggested in the first year. Lists of those brought in may be placed on the board, and the date of the first sign of opening buds on each tree. Children of this grade begin regular sketching of their twigs, to show the position, number, and size of the buds. Beneath the sketch are written simple descriptive sentences.

The special work of this grade is to watch the changes in the buds, as showing the way in which the twig grows. The willow will be the first twig in which this life-history can be traced; the flower cluster grows larger, the brown scale is slowly pushed off, till it drops, and out from the soft, white hairs are seen the flower parts. When fully open, one stem will have large yellow clusters, from which the yellow pollen is scattered. By looking closely, the short stamens can be seen, each with its two boxes of pollen. On another stem will be found clusters of green flowers, with many little pointed parts, which are pistils. These specimens will illus-

trate the two essential parts of a flower, stamens with pollen, and pistils, but on different trees. (*Ten New England Blossoms*, Weed.) A few words about the bees carrying the pollen from one flower with stamens to another with pistils will help children to the simplest truth about flowers, and lead them to watch for bees on the warm days.

The alder is another early twig easy to grow in water in the schoolroom. The long tassels are made of flowers with stamens, as shown by the yellow pollen, which is easily blown about the room. Back on the same stem will be found cone-like bunches, which are made of little scales. These are flowers with pistils, and the scales open to let in the pollen blown by the wind. This also illustrates the essentials of a flower, but both kinds are on the same bush. From some flower on the plants in the schoolroom, the children can find stamens and pistils in the same flower.

Leaf-buds will be the next to watch; and as each change is seen it is reported, and becomes the basis of a conversational exercise. At first the buds are tightly covered by the brown scales, so closely bound that it is not easy to count the scales. Often a smooth or sticky substance covers these scales. Why should the bud be so securely covered? At the next stage the scales have begun to loosen, their number can more easily be counted, the covering is even more sticky than before. What is making the bud open? A little later the scales spread, their shape can now be seen, and it is plain that these scales are really small brown leaves that have a special work to do. The green leaves inside the bud begin to show. How are these new leaves packed in the bud? As the new leaves expand, the scales bend back and are ready to fall off, because they have finished their work for the bud. Now these scales can be picked off, and arranged in order on the paper for further observation. By this time it is possible

to see how the leaves are folded in the bud. Why should they be folded so carefully? As the leaves grow, the new branches appear, which hold leaves or flower clusters, new leaves appear on the sides of this stem, and it is not long before the stem attains its length as a new branch to the tree. Thus the work of the buds is to make new branches. What have the buds needed for this growth? The warm sunlight or the warm room started the sap in the twig, and the water was drawn up to help in the work; all the rest was ready and waiting in the bud. When did the tree get the buds ready?

Fig. 34.

Language. As in the first year, the great stress is laid on the oral expression of the observations and thoughts. The new vocabulary is taught, and from this many descriptive sentences are written. Poetical selections are copied after a simple talk which will impress the beautiful thought. Sketches of twigs are made to accompany the written sentences, and coloring is one of the best forms of expression.

THIRD YEAR.

Life-History of the Buds.

As in the previous years, recognition of the different trees by their twigs precedes the detailed study, but a longer list can be made than before. A more thorough study of a few

twigs is suggested for this year; e.g., elm, hickory, maple, or cherry. (1) The arrangement of the buds on a twig is first noticed as a basis for a sketch, — the terminal bud, its size and shape; the buds along the sides, their size, shape, number, alternate or opposite arrangement, and the spiral order. The thoughts of protection are reviewed as taught in the previous years, also the work of preparation of the buds during the warm season. A sketch showing the facts observed follows.

(2) The steps in the opening of the buds are carefully watched, and a comparison made of the time required for each kind to open; also the difference between the opening of leaf and flower buds is noted. A simple record in the form of a calendar leads to exact time observation. As the bud scales spread they can be studied, — their shape, the outside and inside surface, their number, the colors, the spiral order of arrangement, also their arrangement according to size, and their resemblance to leaves. All of these facts are of value as illustrating the protective function of the buds. The scales can be picked off and mounted in order to show more clearly some of these points. Another twig is then taken as a means of comparison with the first one. While the same general plan appears, there will be many incidental differences. Pictorial drawings are the best forms of expression.

(3) As the leaves expand on the twigs, the arrangement of the leaves in the buds is noticed, their plan of folding so as to pack a large number in the smallest space in each bud. In some the arrangement of the woolly substance is clearly seen as an added means of protection and careful packing. The work of the terminal bud now becomes plain; namely, that of lengthening the stem itself, and thus each year it grows a little. All the growth for the year is packed in these buds, and all over the tree this lengthening of the stems

takes place. The buds on the sides of the stems grow new branches with the leaves on them, and thus the tree spreads out more and more each year. Study a twig to find each year's growth for two or three years, compare the amount, and try to account for the differences. Also from these buds flowers grow which will form the fruit with the seeds for new trees. The steps in the opening of the flowers are watched and described in the same manner as in the leaf-buds. Next summer the tree will be at work preparing new terminal buds, and new buds at the axils of the leaves. The result of this work should be an added interest in watching the trees take on their spring foliage and flowers. Sketches can be made of twigs which show the plan of branching for two or three years, to impress the thoughts already gained. Poetic selections regarding the trees, and any phase of early spring life, are appropriate for memory gems and copying exercises, in connection with their other written expression. A summary of the life-history of the buds in story form might be a fitting close for this series of lessons.

FOURTH YEAR.

Kinds of Buds.

Continued recognition of the common trees by means of their buds. A list, with dates, of the trees in the order of their leaving-out or of the appearance of their flowers. Note the trees in which the flowers precede the leaves, and *vice versa*.

(1) A careful study of one twig, horse-chestnut, will serve as the best introduction. The children should take the twigs, and without detailed guidance tell all they can see about some point suggested. *Scars*, — 1. The leaf-scars, their shape, position, number, arrangement, dots, position of

buds with reference to them, etc. What do they show? 2. Rings on the bark, number of sets on different branches, the distance apart, etc. What do they mean? 3. The scars at the fork of the branches, shape, number on the twig, size, etc. What do they show? 4. Dots on the bark of the twig, position, size, number, meaning. After the children have seen all they can alone, then the teacher guides to any other important points. Any question that cannot be answered should wait until the twigs expand and answer for us.

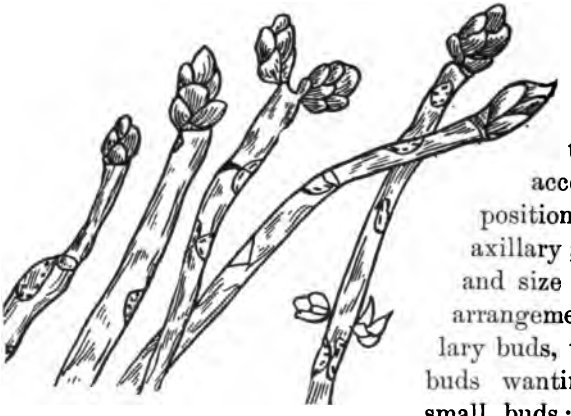

Fig. 35. The Horse-chestnut.

Buds, — the two kinds according to their position, terminal and axillary; the number and size of each; the arrangement of the axillary buds, the number of buds wanting, any very small buds; the covering of the buds, the arrangement of the scales; the arrangement of the branches as compared with that of the buds. Structure of the buds as shown in their growth. These twigs grow well in bottles of water; and as one stage of growth follows another, the parts can be carefully observed. *Scales*, — their lapping one over the other, their relative size, their spiral order, the resemblance to leaves, the rings of scales, the difference between the outside and inside, the wrapping around the leaves. *Leaves*, — the manner of folding within the bud, the way of unfolding, the strong and weak buds, with the order of their opening, the

lengthening of the stem as the leaf unfolds. *Flowers*, — from some of the larger buds will be seen the flower cluster starting; and from the first the form of the cluster can be determined, thus showing that it is already formed in the bud. As it expands, the branches will be noticed growing on its two sides, thus accounting for the scar noticed at the forking of the branches.

Sketches can be made of the twig, of the scales as picked apart and arranged, and of the opening buds on the twig. Written exercises should follow the observation and drawing, and be made according to definite headings. Newell's *Outline Lessons* is especially helpful to teachers.

Fig. 36. Expanding Horse-chestnut Buds.

(2) The potato is another stem with buds which should be studied. In the spring the buds have sprouted sufficiently to prove that the potato is a kind of stem (tuber), and not a root. This gives a good opportunity to bring out the difference between a stem and a root. The potato should be drawn to show the position of the buds and scales on its surface. The growth of the sprouts in the sunlight and in the dark shows the effect of light on the color and size of the stem. The growth underground in a flower-pot will show other differences. The gradual shrivelling of the potato as the sprouts grow shows that it was the storehouse of food for the buds, and thus for the new plant. If a dahlia root is available, it will illustrate a root which stores food for the next year's growth; but it has no buds on the thickened root portion. A sweet potato will also serve the same purpose.

(3) An onion and flower bulbs growing in the schoolroom will illustrate other forms of stems which have stored food

for their buds to use. As the spring advances, the underground stems of grass or ferns will show another plan of growth from buds. The unrolling and expansion of the fern leaves is particularly beautiful. At the close of the lessons a simple summary should be made of the kinds of buds studied, with illustrations of each, — buds on twigs, buds on tubers, buds on bulbs, buds on underground stems, etc. The adaptation of each kind to the plant will be plain. Thus nature's variety of ways of accomplishing the same purpose will be manifest.

FOURTH YEAR.

How Soil Is Formed.

These lessons continue the life history of our common rocks as begun in the previous month. They prepare the way for certain parts of the germination exercises in April, also aid in the geographical studies.

(1) Lead or direct the class to a fresh section of a *gravel-hill;* distinguish gravel, sand, clay, and loam; note the arrangement in the hill, the thickness of the layers, their direction; sketch and label it; collect samples, and arrange in boxes for class study. On the return to the schoolroom make a careful drawing of the layers, representing each in its position.

Gravel. Of what is it made? Of what sizes? What is the shape of the pebbles? Arrange in groups according to the roundness. How many? Think of their original shape; how the angular pieces were broken off, and how they became rounded; why some are more rounded than others. (Refer to the stones in a stream or gutter in a storm.) If near the shore use those pebbles also, and think of the steps in their

formation; use pictures. Why was the gravel, etc., arranged in layers? After the oral description of the facts found, a paragraph may be written to accompany the drawing already made.

Sand. Of what is it made? (Grains.) Of what shape? (Mostly angular.) Are they dull, or shiny? Of what mineral? (Mostly quartz.) What sizes? (Coarse grains, fine grains.) Think how these grains were rubbed off. What are the uses of sand? What great sand areas have you studied in geography? (Use pictures of a desert.) Where are some sand hills or sand plains in town? What trees grow on them? (Written work.)

Clay. Rub between the fingers. What two kinds of substances do you feel? (Fine gritty substance and soft powder.) What is each one? (Rock-flour and clay.) Observe moist clay. How does it feel? Place some moist clay in a bottle, add water; does it soak in and through? Draw a diagram of a spring in a side hill, and have pupils explain the work of the clay. What are the uses of clay? Where are the clay beds in town? Teacher have specimens of decomposing granite or other rock; moisten, and notice the clay odor (decomposing feldspar).

(2) Examine a section of soil in a *plain;* compare with the other; teach parts (top-soil or loam, sub-soil, gravel or sand, clay); collect samples, arrange and label; observe color, size of particles; think of growth of plants in each. Experiments to show the soaking of water through different soils, and the formation of springs and wells. Illustrate by a sectional sketch what is meant by fertile soil? Which places have the most fertile soil? Which places are barren? Notice how vegetation gets a hold on barren soil, — first a growth of mosses, lichens, or poor grass, then low shrubs, then small birches or pines. As the decayed leaves increase the loam,

stronger grasses get a hold, and sods form; finally oak, maple, and other shrubs appear, and a forest growth begins.

In a section of good soil notice how the roots of the grass hold the soil so as to keep the water within it for some time. Notice how the smaller roots of shrubs and trees penetrate and cling to the rich lumps, while the stronger ones push out in all directions for water and support. Each year the loam thickens by the decay of leaves, stems, roots, etc., and new seeds are brought by the wind and water. The farmer turns over the ground with the plough to mix the different elements, and thus increases the depth of the good soil.

(3) Collect rocks which are decaying; observe the weathering, cracking, and crumbling of the rocks; results in the formation of sand, rock-flour, and clay; decaying vegetation aids in fertility of the soil. Thus nature constantly replenishes the soil for the plants to use; and as the streams wear their way down the side hills, the material is carried into the low land, where we find the richest vegetation. In the spring, as the frost comes out of the ground, the pores are opened for the water to wash the fertilizing substances lower and lower; thus the roots of the trees get a fresh supply of food.

(4) A final step will explain how some of the common rocks are formed by the sticking together and hardening of the pebbles, sand, and clay. *Puddingstone* — made of pebbles of different shapes and sizes, grains of sand between the pebbles, fine powder between these grains, all are cemented into one rock. *Sandstone* — made of grains of sand, fine powder between the grains, all cemented, of different colors. *Slate* — made of very fine particles stuck together, different colors, is soft and smooth. Reading from *Brooks and Brook Basins*, Shaler's *First Book in Geology*, or Hyatt's *Pebbles*.

CHAPTER VII.

APRIL.

FIRST YEAR.

How Seeds Grow. — The Little Plant in the Seed.

As the first step in the work, it is well to ask the children to make a collection of different kinds of seeds, large ones and small ones. The collection made in the autumn will serve as an excellent nucleus. Among these should be different nuts, grains, vegetable seeds, grass seed, and flower seeds; for the greater the variety of material for use, the broader will be the truth taught. These seeds should be kept in some neat form for use, and they can be used for "sorting" exercises by the children. Such exercises are valuable in developing power to distinguish at sight, as well as in calling attention to prominent marks of distinction.

1. Coverings of Seeds.

Begin with the nuts, as their coverings are an evident protection for the winter; and as they rest on the surface of the ground, they need a hard, thick covering. Next call attention to the smooth, hard skin found on other seeds. These seeds are smaller, and are usually buried somewhat in the earth. Even the smallest seeds are covered by a skin to protect them while they rest during the winter's cold. On many seeds can be found scars which show where the seeds were attached in the fruit, and where the life of the plant entered the seed.

2. *The New Plant in the Seed.*

By soaking seeds like the bean, pea, squash, or corn, the parts can easily be found. The thin skin slips off, and reveals the swollen, thick parts. These easily separate, so as to show the young plant safely covered between them. This little plant has perhaps so expanded that the parts can be distinguished enough to make out a stem and tiny leaves. In the corn the thick part seems to be on one side of the young plant. Other seeds at hand should be examined for this same purpose, that the thought of the little plant in every seed should be impressed; for this is the essential meaning of a seed. The thought will be started in their minds that the thick parts not only protect the plant, but are a storehouse of food for its growth. This latter thought will become surer as the growth of the seed is watched.

Fig. 34.

3. *Growing Seeds.*

Seeds may be planted by the children in at least three ways for the sake of illustrating different facts in their growth. (1) Some small seeds may be planted on moist cotton floating in a tumbler of water; flaxseed is especially good for this purpose. This plan illustrates the growth of the root with its fine hairs for taking in the water

that the plant needs. From day to day all changes can be carefully watched and reported by the children. Some other small seeds may be tried in the same manner. (2) Beans, peas, corn, acorns, and horse-chestnuts may be planted in a box of moist sawdust. From time to time these can easily be taken out for examination, and then returned. All changes in the different parts can be watched; the thick parts shrivel up as their food is given to the growing plant, and gradually all the new parts of a plant are formed,—root, stem, bud, leaves. No two seeds will grow exactly alike, yet each will form all the new parts. The differences of growth will attract the interest, especially if only one new kind is used at a time. (3) Seeds planted in a box or pot of soil will illustrate the manner of appearing above the ground. If these are all planted on the same day, a simple record can be kept on the blackboard of the time it takes for each kind to sprout, and in some cases this will call for patience on the part of the watchers. As the plants appear, a great many differences will spur on the little observers to report all they can see; their spontaneous thoughts will reveal the child view of nature. These exercises will illustrate some of the needs of a sprouting plant, — the water that the root brings to it, the warmth of the schoolroom, the food stored up in the seed, and the sunlight which makes the new leaves green. The growing plant also needs the good soil for its supply of food, that it may continue to grow.

The language work is largely oral — what the children see and think. Three prominent truths about plant life have been brought out by these lessons, and they have been repeated in many illustrations. The meaning of a seed is the prominent purpose of these lessons. Names of the growing plants can be copied; names of the plants and their parts may be used in many of the reading and copying sentences.

The teacher should make a series of sketches on the board to illustrate the step in the growth of the seedlings. Myths and poetic selections appropriate to the springtime will increase the children's appreciation of the meaning of this season in nature's work. A new sympathy in accord with the spring awakening is the aim.

SECOND YEAR.

How The Young Plant Grows.

The collection of different kinds of seeds should be made as before. The facts about the coverings of the seeds should be reviewed if they were taught during the first year. Also the new plant should be found in various soaked seeds. Dry and soaked seeds are sketched in outline to show the swelling as the first step in the growth.

1. Parts of the Seeds.

These are apparent in the soaked seed, and can be observed quite carefully by picking the seeds apart with a pin. The children should be encouraged to tell all they can see or think about the skin: it is smooth, thin, tough, fits the seed perfectly, slips off easily, is often transparent, etc. It protects the thick parts, and keeps all close together; but when the seed is done with it, then it slips off easily. In the same way the thick parts are described, — their number, size, color; they are made soft by the water, taste sweeter, slip apart easily. They cover the little plant, as well as supply food for it to grow. The little plant is found, and its position carefully observed; also the parts that can be made out, the small stem, the folded leaves on the end of it. The direction in which it has started to grow is usually apparent. A sketch

of these parts makes the second in the series. This seed can be put aside, and others used to impress similar facts. The essentials are a skin, food, and a plantlet; all these seeds will have these.

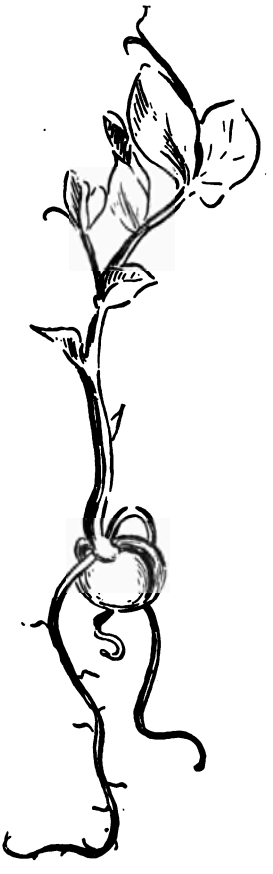

Fig. 38.

2. Formation of New Parts.

The same three plans of planting may be used as in the first year. More careful observations can be made of the parts as they form. The stem lengthens, carrying the leaves up with it; the root begins to appear at the lower end of the stem, and as it grows down into the water the hairs are carefully watched for, because these suck up the water. Often the fuzzy appearance is all that can be seen. On the upper end of the stem the green leaves appear between the thick parts, which grow smaller as the new parts grow. Now we have the essential parts ready for the plant to use, — root, stem, leaves. Other seeds will show the same parts. The seeds planted in the ground will show many differences; in some the thick leaves are pushed up above ground, while in others the green leaves are the first to appear, but there is the same general plan of growth. It is the process which is to be watched by the children, and reported. Then they sketch one of the plantlets with its three parts.

3. Growth of the Parts.

As the growth continues, the changes are particularly noticed, in order to see how the young plant is going to take care of itself. The root grows longer, and throws out some branches to help it cling to the earth, as well as to get more water. Many little thread-like rootlets grow out all along its sides. This is seen in the seeds growing in sawdust, and by pulling up one from the soil it can be shown how firmly it clings. The stem also has lengthened, and buds appear, which grow into new leaves. Soon the branches appear, carrying the leaves upward and outward into the sunlight and air. The different ways can be watched best in the plants growing in the soil. In time buds will form that have flowers in them; these will bloom and ripen into fruit which contains seeds, and the cycle of life is completed. The series of sketches is continued to show the branching roots, and the branches of the stem bearing leaves and buds. Sprouting seeds brought in from out-of-doors will show the same parts at work in the same way; e.g., maple and ash plantlets.

Oral language is still prominent in describing plant growth. Names of parts and their qualities are used in sentences, which may be written from the vocabulary, in answer to questions, or in original forms. These descriptions may accompany the simple sketches. Copying of interesting poetic selections is helpful, also the reading of some of the best myths about springtime. How the plant grows from seed to seed is the thought to be impressed in this grade.

THIRD YEAR.

Differences in Seeds.

Collections of seeds should be made, as in previous years; and these can be grouped, (1) those with a very hard cover-

ing, such as nuts of various kinds and the stone fruits. It will require the frost of winter to break this covering, and many nuts can be found in the spring which have been thus broken. (2) Those with a thick skin; e.g., horse-chestnut, chestnut, acorn. By planting these in moist sawdust it will be found that the young plant has force enough in it to break through the hard covering. (3) Those with a thin skin; e.g., bean, pea, squash. These are easily burst by the growing plant; just the swelling is enough to break the skin. Lists of these groups can be made on the board, and they will serve as texts for oral or written descriptions.

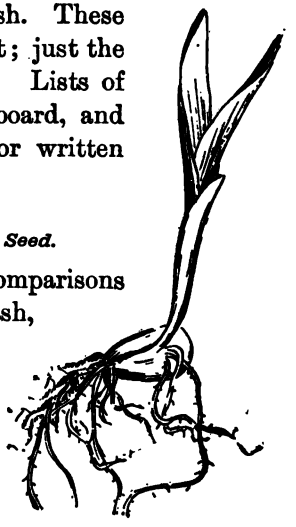

Fig. 39. Sprouting Corn.

1. Arrangement of the Parts in the Seed.

This is best found by a set of comparisons between two seeds like the bean (squash, pea) and corn. (1) Sketch the dry seeds of each; follow this by a sketch of the same seeds soaked for twelve hours. This is to emphasize the changes in size and shape as the first change that comes to a sprouting seed. The two should be compared to see if they change alike. A careful oral report is made of this comparison. (2) Study the soaked seeds together for comparisons; the outside skin and the effect of the soaking. Which slips off the easier? Next the parts that can be distinguished, with their names; the two thick cotyledons of the bean with the little bud (plumule) between them. This has a distinct stem (caulicle), and two small leaves already formed. A sketch on the board with names attached will help fix the names, and they

should be used constantly in the oral and written descriptions. The cotyledons can be spread apart and a sketch made.

The corn is quite different. On one side of the seed is the single cotyledon; and the little plumule is only slightly developed, while the largest part of the seed is taken up with the food stored for the young plant. This should be sketched by the side of the bean and pea.

2. Growth of the Seeds.

(3) Sprout the seeds in the moist sawdust, and report the differences in the ways of growth once or twice a week till the plants have developed their plan of growth. After they have sprouted, a few seeds can be placed on floating cork, with the roots inserted through holes in the cork; this plan allows free observation of the growth of all the parts. The roots, stem, leaves, buds, as they develop, should be sketched at the different stages. The cotyledons will be prominent in the changes in the bean, but little noticed in the corn; the main root with its branches will differ from the clustered rootlets of the corn; the broad, unfolding, net-veined leaves of the bean are markedly different from the uncoiling parallel-veined corn leaves. This will impress the truth that different plans accomplish the same result. Children may be tested by a few simple questions written on the board. (4) Seeds sprouted in the soil. Large, medium, small, and very small seeds may be planted at the same date, the record being made on the board. The conditions are kept the same, and comparisons are made and recorded; the number of days required for each to appear above ground; the first thing to appear, cotyledons or plumule; the time required for the first leaves to fully open; the kinds of leaves and arrangement of the branches, etc. Under each of the four

headings a careful record is made for the purpose of developing observation of details. The horse-chestnut, acorn, squash, and grass seed will serve as illustrations of four that may be selected. The record should be carefully copied by the children.

PLANTED APRIL 4.	DATE SPROUTED.	WHAT APPEARED.	DATE OF 1ST BRANCH.	KIND OF LEAVES.	RESULT MAY 4.
Horse-chestnut,					
Acorn . . .					
Squash . . .					
Grass					

Many other differences will be noticed and orally reported, for the object is to see every change that takes place. The thoughts regarding the meaning or value of any of these steps are to be encouraged, always referring to nature herself for the answers to unsettled questions. The aim of this year's work is power to compare processes of growth.

FOURTH YEAR.

THE CONDITIONS OF PLANT GROWTH.

This work is more advanced than the previous, and the children are to find truths of nature by simple experiments. As far as possible the planning and care of the experiments should be theirs, in order to make the meaning more real to them. These experiments relate to the conditions of soil, moisture, and sunlight. One factor only is varied, while the other conditions remain as nearly alike as possible. One day each week is used for the observations of each set of experiments.

Soil.

Four or five dishes or pots are prepared, and the conditions carefully talked about as to their object.

1, Peas, beans, or corn are planted in sand; 2, Clay; 3, Loam; 4, Gravel. These are all kept in the sunlight in the warm room, and equally well watered. Let the children think out the best conditions, and learn to wait for results, not

Planted April 4.	Date of Sprouting.	Appearance Second Week.	Length, Inches, Third Week.	Appearance Fourth Week.
No. 1 . .				
No. 2 . .				
No. 3 . .				
No. 4 . .				

anticipate them. On the selected day the observations are carefully made, the record filled out and copied, and the various thoughts discussed. More patience is also suggested before conclusions are drawn.

The thought to be emphasized is the value of good soil to a plant, and suggestions as to what it can supply as food for the plant. Geographical illustrations and applications should be made from the local neighborhood. Let the children select illustrations, and tell the amount of vegetation and kind found in each soil.

Moisture.

In a similar manner it is decided to plant seeds: 1, In a very wet soil (keeping it so all the time); 2, In soil with average moisture; 3, In a dry soil. These pots of soil are kept in the same conditions in other respects. Another day in the week is selected for this series of observations.

Planted April 5.	Days to Sprout.	Appearance Second Week.	Appearance Third Week.	Result Fourth Week.
No. 1 . .				
No. 2 . .				
No. 3 . .				

The thought to be emphasized is that of an appropriate supply of water, and nature's way of giving it. Application can be made to deserts, to the kind of vegetation found in swamps, and to the conditions of ordinary vegetation. As a weather record, keep a careful list of the number of half days or nights of rain during the four weeks, to find nature's provision for vegetation. A simple rain-gauge may be made by placing a large tin can, with slightly flaring edges, on the ground during the storm. Afterward the depth in tenths of an inch measured, and placed in a table for the month. The amount will only be approximate, but will emphasize the thought in mind.

Sunlight.

Three experiments can easily be thought out to answer the question of the need of sunlight. No. 1 is kept in a sunny window. No. 2 is kept out of the direct sunlight. No. 3 is kept in a dark closet.

Planted April 6.	Date of Sprouting.	Length in Inches.			Color of Parts.	Result Fourth Week.
No. 1 . .						
No. 2 . .						
No. 3 . .						

The thought to be emphasized is the essential work of sunlight in giving warmth and producing the green color of

vigorous growth. To show nature's plan, apply the weather record for the month by noting the days that are sunny in whole or part; also use the almanac to get the length of each day; keep the table on the board; find how much the day has lengthened during the month. If it is not feasible to try all these experiments, select one line, and faithfully derive its lesson. Different rooms of a building can divide the work and compare results; thus each room gets the full value of its own work, and derives something from the others.

The records are carefully kept; this is a valuable form of expression. Exact seeing and describing of experiments and observations is one of the best forms of oral work. The free expression of the thoughts will give variety of language, and many of the results will be surprising to those not familiar with the facts. The aim of this work is to learn how to question nature, and how to read her answer honestly and with faith. A simple beginning may be made in these years.

CHAPTER VIII.

MAY AND JUNE.

Spring Life.

The exuberance of spring life is very attractive to children; and its different phases should be noticed, particularly that the relation of all may be appreciated as parts of this great growing world of life. Many lines, especially of animal life, may be used incidentally, while the more available plant life can be used for careful schoolroom observation. The use of the material and the way of presenting it should lead the children into the spirit of the fresh growth about them. The child view of nature is first to be found, in order that the right starting-point for the work be secured; thence the child can be led up to one truth after another, according to his own natural development.

FIRST YEAR.

Animal Life.

During the month of April the birds were looked for as they came back from the south. Now the birds have mated, and are busy gathering the material for their nests; soon the mother-bird will be sitting on the eggs, and later both parents will be gathering food, and carrying it to the young birds. Still later the young birds will be taught to fly for themselves. Thus the home life of the birds is emphasized. Some

old nests may be brought in to show the material used, and the arrangement of the parts to make a strong nest. These nests may be placed among the branches of some small tree in the corner of the room, to show how the birds may select a firm place for the nest. Most of this is a conversational reporting of the observed habits, followed by the thoughts natural to children. Another form of animal life peculiarly interesting to children is the insect coming from its cocoon after the long winter rest. So great a change has taken place in this cocoon that we should not recognize the crawling caterpillar in the beautiful butterfly. Caterpillars are seen on the leaves of many trees, fitted by color, legs, and jaws to crawl about and eat the soft vegetation, often doing great injury, especially if the birds have been driven away. This can easily be illustrated by placing a twig on which the caterpillars are feeding in a bottle of water, covering the leaves with netting. The butterfly is changed from the previous form of life so as to fly from flower to flower, and with its long tongue suck the honey without injuring the flowers. This can be shown if not already noticed. Soon the butterfly will lay her eggs, and caterpillars will hatch to again go through the changes that fit them for their peculiar life. The wisdom of the cocoon stage is apparent to all.

Flowers in the Schoolroom.

Both wild and cultivated flowers will be brought in by the children in fresh variety as the season progresses. Let the teacher guide in the proper collection and artistic arrangement of the contributions. In many cases school gardens, or at least window gardens, can be planted, which will not only beautify the grounds, but teach the children to care for the growing plants; they also will provide illustrations for

Fig. 40.

the school exercises. A variety should be sought, bunches of wild flowers transplanted, typical flower and vegetable seeds planted for the sake of comparison. Many hardy shrubs may be transplanted in the school garden. (The Massachusetts Horticultural Society of Boston has some publications helpful to teachers along this line.) Do not neglect to look for some of the flowerless plants, — ferns, mosses, and lichens, in their natural homes, thus expanding the idea of a plant.

Colors of the Flowers.

Let the children make suggestions about the arrangement of the flowers to give the best effect to their beauty. By a color chart they may recognize the principal colors of the flowers. Let them select colored papers to be mounted and hung beside the flowers. A number of colors will be selected for some flowers, and the idea of harmony perceived. The flowers are to give beauty to the world, as well as to attract insects. Some poetic selections regarding individual flowers may be read to still further impress the thought of the beauty of the flowers. The arbutus, anemone, bluet, marigold, violets, buttercups, clovers, and daisy are examples of the range of beautiful colors running through the spring. (Dana's *How to Know the Wild Flowers* groups plants by the colors of the flowers, and is helpful to teachers in recognition.)

Life of a Flower.

The youngest school-children can trace by observation the life of the flower, from the first appearance of the green bud, through the gradual unfolding, till the colored leaves are seen enclosing the stamens and pistils. The yellow pollen is an evidence of the ripe flower, and at this time the bees are busy

getting the honey. Gradually the flower leaves fade and fall, the stamens soon follow, and the green fruit appears. When the fruit is ripe it is ready to split open and let the seeds escape, to be ready to make new plants the next spring. The violet is a good plant to use in tracing this life-history; also the dandelion and buttercup.

The Work of the Plant.

The best way to teach the simple parts of a plant is by thinking of the work each does for the growth of the flowers and fruit. The roots in the ground suck up the water as well as hold the plant firmly against wind and storm. There are many threads to the roots, and they spread out so as to do this work in the best way. Different plants have different kinds of roots, each the best for its own use. The stem carries the water and food collected by the roots to the leaves and buds which it holds along its sides. Different stems will also be noticed; some of these, such as the rhubarb and asparagus, are used for food. The leaves are at work also for the plant in taking in the sunlight and air. Thus all are working together to make the seeds for next year. Simple sketches can be made of a plant with these parts, also of the parts separately. The plant vocabulary is being learned in connection with the early language exercises. A simple series of reading sentences can be prepared that will give the truths taught in their natural order.

SECOND YEAR.

Animal Life.

In addition to the observation suggested in the first year, the development of frogs' and toads' eggs may be watched. Only a few eggs should be kept in the jar of water, and por-

tions of the water should be renewed. It is better to keep the jars out of the direct sunlight. The mass of jelly in which they are laid protects the eggs. Two parts of each egg can be distinguished, one of which (the yolk) is food for the young tadpole. When hatched, it swims about like a fish, and often the gills can be seen on the sides of the head. The tadpole at first feeds on fresh-water plants, which should be placed in the jar; later it feeds on small animals found in the fresh pond-water supplied from time to time. The legs appear gradually; finally the animal fasts, absorbs its tail, and becomes an insect-eating frog or toad. It would be well in June to have a frog in a little water in a jar, or a toad in a jar of sand, for the purpose of watching the habits.

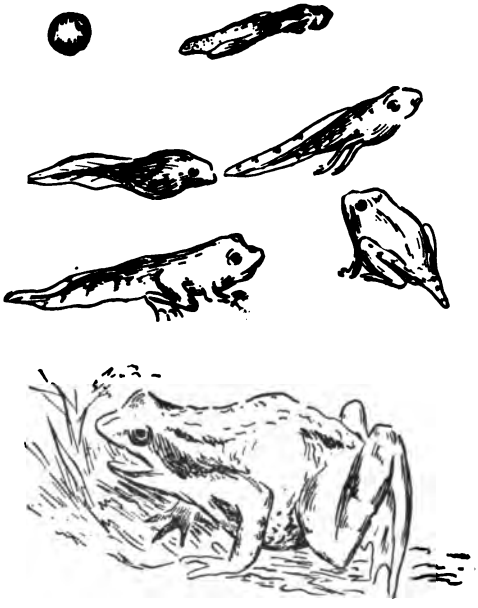

Fig. 41. Development of Frogs.

Plant Life.

More can be done this year in collecting different kinds of plants. Lists should be written on the board according to the colors of the flowers, and the locality written beside

each (swamp, woods, dry fields). But the collection should not be limited to flowering-plants. In the lower forms the children should see how many plant parts can be found, — root, stem, leaves, fruit, spores. In a box of moist earth ferns and mosses may be transplanted, and lichens on bark and stones mingled with them. Devices with colored papers, and colored illustrations in the weather record, increase the interest in observing. Appropriate poetic selections furnish reading material, and flower myths may be told to the children. Some of the plants are simple enough to be sketched with all their parts, — anemone, bluet, violet, etc. Coloring is one of the best means of expression; for this, colored pencils may serve, if no other material is at hand. The color gives the evidence of life.

Parts of the Flower.

Direct in finding the parts, teaching the names, — sepals, petals, stamens, pistil. A sketch kept on the board with names attached will help fix these names in the vocabulary. Notice the colors, position, number, and form; think of the protecting leaves, the colors, and odors attracting the insects; find the pollen on the stamens; look for pistil forming fruit with seeds in it; think of the scattering of the seeds. A bunch of violet plants growing in the room will illustrate the stages in the flower life. In many flowers the four parts will not all be found; the petals are wanting in a number of the spring flowers (marsh marigold, anemone). The flowers of the fruit-trees are large enough for easy examination, and the steps in forming the fruit are clearly traced. After using the new names in oral sentences, the best ones may be written for reading or copying exercises. Then written sentences may be formed from the vocabulary. A series of

reading-exercises may be prepared by the teacher, if not available in a reading-book.

Parts of Leaves.

Trace the sap in its movement through the stem (petiole) into the midrib and veins of the leaf (blade) till it fills the network of small veins between which is the green pulp. This will impress the nature view of the parts of the leaf. The petiole is particularly examined to see how the leaf is firmly attached to

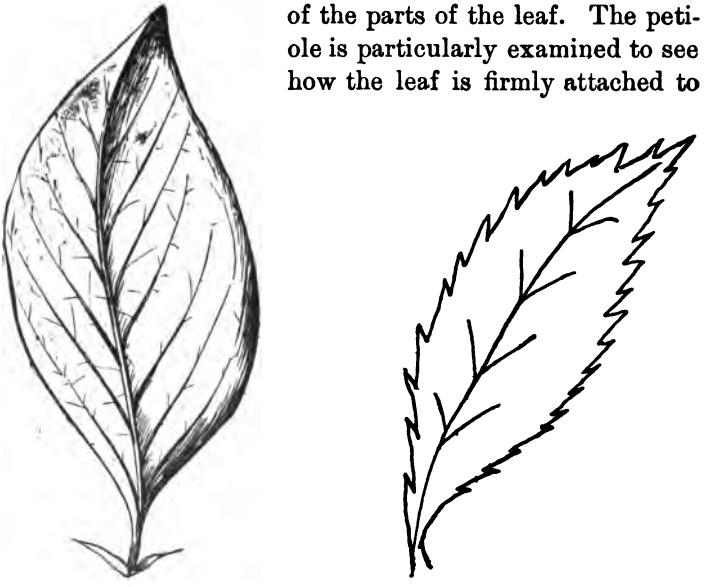

Fig. 42.

the branch; the ribs and veins are a framework for the leaf, holding it out in the sunlight. A sketch of a leaf with names attached is used to fix the names. Other leaves are observed to find the same parts, although the arrangement differs. Some of the simple forms can be drawn or colored, and

the sentences written beside them. This series of sentences should cover the main facts of observation that the language may keep pace with it.

THIRD YEAR.

Bird Life.

While quite a list may be recognized by color or habit, a few birds are selected for continued observation during the spring, in the hope of arousing much enthusiasm in bird life.

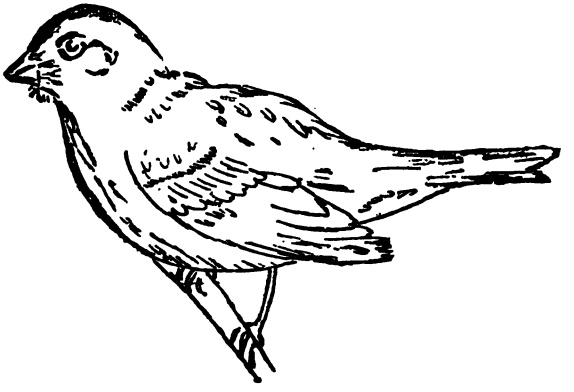

Fig. 43.

The simplest list might consist of a live canary in the school-room, the robin and woodpecker around the school-yard, the hen or duck at home, and birds seen in the neighboring trees. A great aid to this study will be short walks taken by the teacher with groups of children. (*Birds*, Nature Study Publishing Company, Fisher building, Chicago, has colored plates, and reading-matter of great assistance to teachers in becoming familiar with our common birds. *Birdcraft*, Wright,

also has colored plates, and *Citizen Bird*, by the same author, is particularly helpful in interesting children in the out-of-door observation of bird habits. Chapman's *Birds of Eastern America*, is a valuable aid.)

The points to be observed include the general colors which aid in distinguishing the bird, — the movements, how it eats, drinks, sleeps, keeps its feathers clean and oiled, sings or calls, builds nest, cares for its young. The relation to insect life is an important point to emphasize, so that the great value of the birds is appreciated. By all means let "Bird Day" be observed in a way to increase the interest, not only in the school, but in the community. Literature is full of selections for use.

Parts of a Bird.

A closer observation is facilitated by some stuffed specimens, which may be borrowed or contributed. The colors of the head, breast, back, wings, and tail are selected by comparison with the color chart. After selecting the colored papers they may be mounted, in order to illustrate the variety and harmony of colors in one bird.

The kind of feathers, — the long quills of the wings and tail help in flying, the smaller feathers lap over one another so as to cover the body perfectly, and the soft down next to the body keeps it warm. A collection of hen's feathers will illustrate these points, and serve as material for the drawing-exercise.

The horny bill picks and crushes the food, — delicate in the canary, but strong enough to crush smaller seeds; larger in the robin, to collect worms and crush larger seeds; straight and strong in the woodpecker, for pecking the trees; stout and curved in the hen, for picking food scratched from the

ground; flat in the duck, with a strong cap on the end for finding food in the mud. Each is adapted to the need of the bird.

The legs and toes also illustrate this adaptation, — slender in the canary, for perching; broader and stronger in the robin, for running along the ground; toes in pairs in the woodpecker, for running up and down trunks of trees; large and stout in the hen, for scratching; webbed in the duck, for swimming, with short hind toe. Sketches of the head and bill are possible to accompany any written descriptions appropriate to the grade. Carefully prepared questions aid in developing the language expression.

Plant Life.

The flowers need not be neglected on account of the bird study. Lists can be made of the flowers recognized, their color indicated, and the locality where they grow. The special work of this year is to find the special adaptation of the parts to the life of different plants, — the kind of roots, thinking of their value to each plant; the kind of stem (position, length, size, etc.); the kind of leaves (shape, petiole, veins, arrangement on the stem); the parts of the flower, their color and arrangement; the fruit when present. Some of the plants can be drawn, also the leaves and flowers. The arbutus has a trailing stem, hiding its delicate flowers under the tough leaves for protection. The flower is a little tube, with nectar at the bottom of the corolla cup; and it is lined with fine hairs which may be to keep the water out. The early bumblebees, that have lived in some sheltered nook during the winter, crawl from blossom to blossom, and with their long tongues suck the nectar. As the bees do this, they will carry the pollen from one flower to another, and thus help

in the formation of seeds. The mesh of hairs keeps out the ants, who could not carry the pollen.

The marsh marigold has a root, stem, and leaves fitted to live in moist places; its large yellow sepals serve also as petals to cover the stamens and pistils. The golden yellow flower is wide open to insect visitors.

The dandelion is a particularly good illustration of the adaptation of parts, — the thick, juicy tap-root gathers an abundance of food even in poor soil; the long, coarsely toothed leaves grow directly from the ground, but spread out to get sufficient sunshine and air to do their work; the cluster of strap-shaped flowers is protected by circles of green leaves, which close about the little flowers at night or during a rain. Each floret has its stamens and pistil, and a whole head of small flowers will be very attractive to the insects. As the seeds ripen, a bunch of silken threads grows up on each one, ready to sail away with it in the wind. No wonder dandelions are so plentiful along the roads and in the yards.

The early buttercup has a bulb just below the surface of the ground, wrapped about with leaf-like parts; in this is stored the food for the plant, and from it grow many thread-like roots. The palm-veined leaves are cut into three main parts, each with many divisions; these are held out in the sunshine by long stems, which reach high above the thick grass. The butter-yellow flowers also are held out on long stems; all the parts are easily distinguished (sepals, petals, stamens, pistils), and the whole is open to a great many insects. The stamens ripen a few at a time, and thus the life of the flower is lengthened for insect visits. The process of the ripening of the pistils into fruit is plainly marked, and the hook on each little part helps it get a foothold to begin its new life.

The red clover, field daisy, cinquefoil, columbine, lady's

slipper, wild geranium, and many others will teach valuable lessons of the adaptation of parts to habitat, and of the work of insects about the flowers. Newell's *Botany*, Part II., is helpful, also Hardinge's *With the Wild Flowers*.

FOURTH YEAR.

Animal Life.

By this time the children are able to think of animals in groups. It is suggested that the beginning be made with backboned animals, or vertebrates. Let the children think out a list of domestic animals that have backbones; it is noticed that our strong animals are in this list, — horse, cow, cat, dog, etc.; that the birds, the frogs, and fishes also are among them. It is noticed that the animals we can train are among them, for they have brains protected by the bony skull. They also furnish many useful things, — meat, milk, eggs, hides, bristles, horn, glue, feathers, etc. It is shown to be a very important group of animals. Let them think of animals that do not belong to this group, — oysters, clams, insects, etc. Make a double list on the board according to this basis of division.

The Fish.

Some small fish may be kept in a jar of water in order to watch the movements and other habits. Full suggestions for keeping fish in an aquarium are given in Wilson's *Nature Study* (Macmillan & Co.). The live fish are to be watched, and certain questions may be used to guide the observation along valuable lines. How does a fish move? How does he eat? How does he breathe? How much does he know? Oral reports are made by the children from time to time.

A large fish obtained at the market may be suspended against the blackboard, where all can easily see it. The following points suggest the line of thought: the boat shape of the fish, as adapting it to move easily through the water; the slippery covering over the scales which aids in gliding through the water. The scales can be examined further, to show their nature and arrangement; a few can be taken off and drawn. The various fins are carefully distinguished; those along the back and on the under side keep the fish in position, the tail is used to move forward, the front pair and the hind pair aid in movements up and down or sideways. The

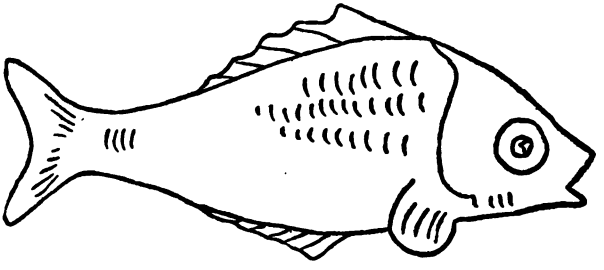

Fig. 44.

fish in the jar illustrate these movements, and the perfect ease of moving is appreciated. Of the head parts the circular eyes are prominent, no eyelids are found, but the eyes are protected by the thin membrane. The nostrils are small openings on the snout; the teeth are many and sharp; they point inward to hold the slippery food. Back of the head are the gill covers, which protect the four pairs of red gills by which the fish breathes the air that is in the water.

The backbone of a cooked fish is an excellent means of teaching the structure, for the small vertebræ and their spines are distinctly seen; also the column for protecting the

nerve cord. The flexibility and strength are manifest. A drawing may be made of one of the bones. The whole fish is sketched, and descriptive sentences are written from a series of headings, — color, shape, fins, gills, etc.

Other Vertebrates.

In the country the turtle can be brought in by the older children, and will serve for an illustration of adaptation of parts to habits.

Frogs' eggs in masses, and toads' eggs in strings, may be hatched as suggested previously, all the stages of development being noticed. A series of sketches on the board will aid in the observation. Compare the living frog and toad; color of skin (protective); adaptation of legs to movements (in water and on land); mouth, teeth, tongue, fitted for insect food (the slimy tongue is attached in front, and thrown out as a blow at the insect); eyes and ears prominent; breathing by a swallowing movement. The great value of the toads in our gardens is easily shown, and impresses children.

Birds.

The purpose of the out-of-door observation this year is to get as well acquainted as possible with a few of the common birds. Each subsequent year a few more are added to the acquaintance. The robin, bluebird, blackbird, woodpecker, song-sparrow or chipping-sparrow, swallow, cat-bird, and oriole are good ones from which to select. Some of these birds are tame enough for the study of their habits, while others may be known by color, song, or some special habit.

A list is kept on the board, and a few points noted for the purpose of keeping all the children on the watch.

NAME.	DATE WHEN FIRST SEEN.	WHERE SEEN OR HEARD.	COLORS PROMINENT.	HABITS NOTICED.

It is not easy to describe the colors of the different parts, hence a careful plan of observation is needed. By a series of reports on the color of one bird, e.g., robin, a little is added each time, until finally the children can see colors with considerable skill. A color chart will aid very much in selecting the right colors. This habit well started is of great value in the later study of birds.

In the morning talks the children should report carefully the habits they have observed; where the birds are building their nests; what they find to use; their habit of movement; e.g., the robin running and hopping along the ground, stopping to listen for the movement of worms, or the woodpecker climbing up the trunk of the tree, or the chattering flock of blackbirds, flying from bush to bush; what they find to eat; e.g., earthworms, insects under the bark, fruits, and seeds. Think of the adaptation of the parts, especially the bill; e.g., the strong bill with a curved tip is fitted to pick and pull earthworms and insects; the straight, sharp-pointed bill is fitted to tap into the bark of trees for insects, also to dig out a hole for a nest. The eating of fruits by birds helps to scatter the indigestible seeds, and the eating of the seeds of weeds helps to prevent their spread; each service is a useful one. The adaptation of the feet and toes should be noticed, as suggested in the third year.

The best use of language is in the oral reports and thoughts, and in the myths, poems, and reading-lessons on birds, of which there is an abundance. Wilson's *Nature*

Study gives a full and carefully prepared list. The reading of *Citizen Bird* to the children will enkindle an increased interest.

The Trees in Bloom.

If plant work is preferred for this year, the watching of the trees as they flower is an interesting and valuable study. A list on the board will emphasize the order of flowering, also some special point regarding each.

Name.	Date.	Peculiarity.
Willow	*Early Spring* .	Yellow staminate flowers on one tree; greenish pistillate flowers on another tree.
Birch and Alder,	*Early Spring* .	Long staminate catkins, small cone-like pistillate flowers on same tree.
Elm	*April and May*,	Flowers before the leaves, fruit with one seed and a wing.
Maples	*April and May*,	Different colors; clusters of two kinds of flowers; fruit, a key with wings.
Horse-chestnut .	*May*	Irregular flowers, attractive colors for insects, few ripen into fruit.
Fruit-Trees . .	*May*	Regular flowers, parts easily found.
Oaks	*May*	Long hanging clusters of staminate flowers, small pistillate flowers form acorns.
Pines	*May and June*.	Clusters of staminate flowers, with much pollen; small scaly pistillate flowers form cones.

These illustrate some of the different ways in which plants flower, but all agree in having stamens and pistils. Those

with bright colors or sweet odors will attract insects to carry the pollen, others must depend mostly on the wind to scatter the pollen, and so the flower makes a large amount of it. The formation of the fruit should be carefully watched, thus supplementing the autumn work on the same subject.

Sketches can be made of twigs with flowers in position, also of the leaves and fruits. Poems on the trees are helpful for reading-exercises. The collection of fruits begun in the fall can be increased.

REFERENCES.

THE following are a few of the helpful books for teachers: —

PLANTS.

BERGEN'S *Elements of Botany* (Ginn & Co.) gives the latest botanical facts in condensed form.

NEWELL'S *Outline Lessons in Botany* and *Readers*, Parts I. and II. (Ginn & Co.), give details about individual plants.

DANA'S *How to Know the Wild Flowers* (Scribners) will help in distinguishing plants by the color of their flowers; it also gives some interesting habits.

HARDINGE'S *With the Wild Flowers* (Baker & Taylor, New York) is particularly good on the relation of insects to flowers.

WEED'S *Ten New England Blossoms* (Houghton, Mifflin, & Co.) describes plant habits; also emphasizing insect fertilization.

DANA'S *Plants and Their Children* (American Book Company) is full of suggestions on plant life and development.

FLAGG'S *A Year among the Trees* (Educational Publishing Company) is written from the naturalist's point of view, and consequently is very suggestive in nature thoughts.

APGAR'S *Trees of Northern United States* (American Book Company) gives the distinguishing features of the trees by families, enabling a person to identify our common trees.

MORLEY'S *A Few Familiar Flowers* (Ginn & Co.) works out the facts of plant life in a form adapted to the children.

RUSSELL'S *Native Trees* (New England Publishing Company) illustrates and describes New England trees without the technicalities of botanical science.

ANIMALS.

COMSTOCK'S *Insect Life* (Appletons) and WEED'S *Life Histories of Insects* (Macmillan) will give the facts about insects; suggestions for finding and caring for them; and the latter book furnishes interesting reading for the children.

WRIGHT'S *Citizen Bird* (Macmillan) describes bird habits in a story form adapted to children. *Birdcraft*, by the same author, describes habits, accompanied by colored drawings. CHAPMAN'S *Handbook of Birds of Eastern North America* (Appleton) gives the full classification and descriptions.

COOPER'S *Animal Life in the Sea and on the Land* (American Book Company) gives the range of animal life in popular form.

SAMUEL'S *Amateur Aquarist* (Baker & Taylor Co., New York) has full directions how to equip and maintain a self-sustaining aquarium

MINERALS AND SOILS.

SHALER'S *First Book in Geology* (D. C. Heath & Co.) tells of the earth materials and processes about us.

HYATT'S *Pebbles* (D. C. Heath & Co.) is a small pamphlet history of the common formation of pebbles and sand.

FRYE'S *Brooks and Brook Basins* is a first step in geographical application of nature study.

MYTHS, POEMS, ETC.

WILTSE'S *Morning Talks* (Ginn & Co.) suggests a course of conversational stories for each month of the year.

COOKE'S *Nature Myths and Stories* (Flanagan, Chicago) adapts material to little children.

GAYLEY'S *Classic Myths* is a more advanced summary of the myths in English literature.

WILSON'S *Nature Study* (Macmillan & Co.) gives full lists of myths, poems, and songs for elementary grades.

LOVEJOY'S *Nature in Verse* (Silver, Burdett, & Co.) arranges poems by the months.

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